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ABSTRACT

This document summarizes the activities of the U.S. Agency for International Development (USAID) assistance program at Makerere University's Faculty of Agriculture. Under the terms of the agreement, West Virginia University provided the services of a senior agricultural educator to work with the faculty and develop a long-range program of assistance and development. Following a presentation of historical background and contract objectives, the implementation of the contract is reviewed in relation to the West Virginia University staff, agricultural faculty staff, government of the faculty, instruction, research activities, conferences, contract consultants, West Virginia University's contribution, and institution building. (MJM)

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Terminal Report
Contract USAID/afr-411

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# AGRICULTURAL EDUCATION IN UGANDA

MAKERERE UNIVERSITY

International
Programs

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
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West Virginia University
MORGANTOWN, WEST VIRGINIA
IP–51 MAY 1972

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# TERMINAL REPORT

## WVU/AID/afr-411
## WEST VIRGINIA UNIVERSITY-USAID PROJECT
## AGRICULTURAL EDUCATION IN UGANDA
## MAKERERE REGIONAL

## INTRODUCTION

The basic policy underlying the foreign assistance program of the United States has been to provide assistance in the development of agencies and institutions of the developing countries that would lead to a rapid advance to take off point of self-sufficiency on the road of economic and social development.

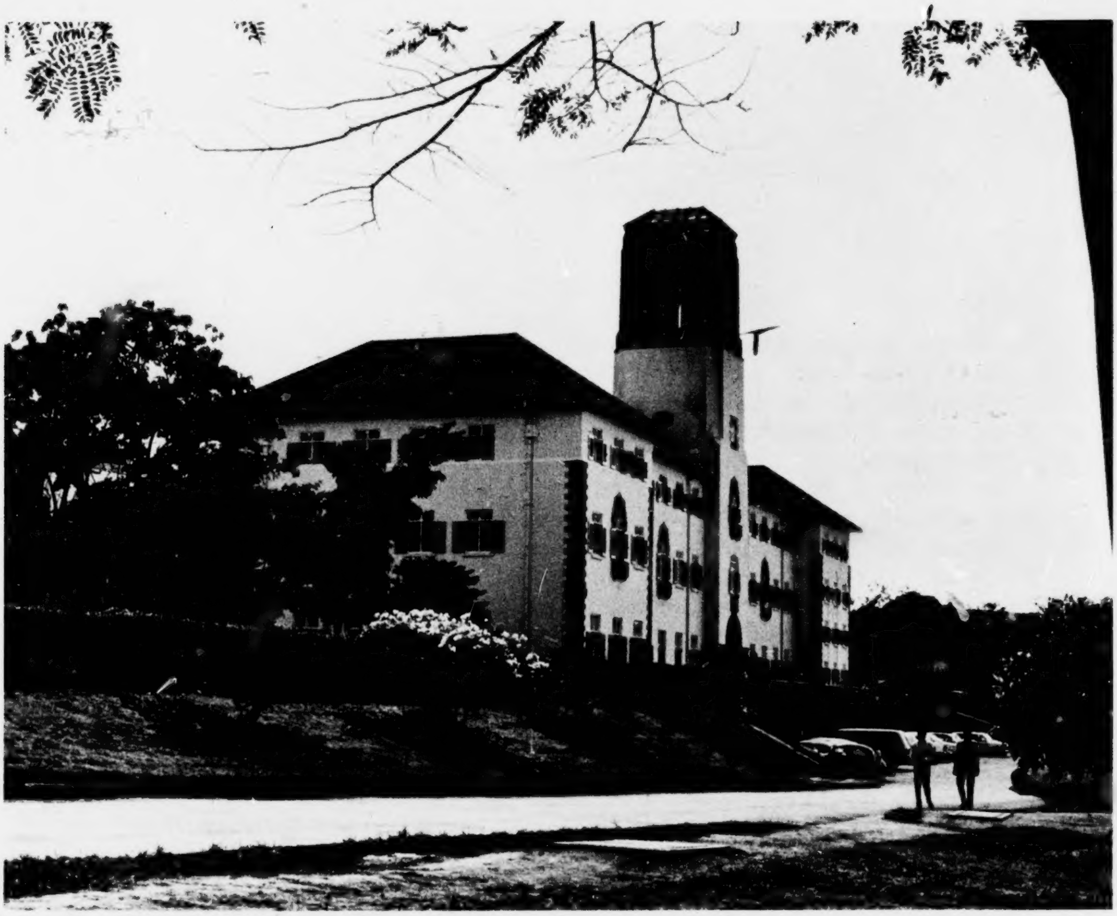
Agriculture and education have been the primary foci for development and technical assistance in East Africa. West Virginia University has been the contractor through which much of the technical assistance in Agriculture Education provided by the USAID has been channeled to the East African countries of Kenya, Tanzania and Uganda.

The development of the Agriculture Sector of the economy of any country requires a supply of well-trained manpower at every level of operation. To assist the East African countries to develop a pool of trained manpower, the USAID has funded programs of assistance in Agriculture Education in secondary schools, technical colleges and in university programs leading toward professional degrees.

The program of assistance to the Faculty of Agriculture, Makerere University, although the last to be implemented is of primary importance since it was designed to provide the high level manpower required to continue and institutionalize programs implemented to produce technically trained manpower, to staff these agencies and institutions and to provide the leadership required for continued progress.

Makerere had an established program leading to the B.Sc. Degree in 1964 when the contract was first implemented. The technical assistance program was therefore directed to the expansion, elaboration and consolidation of this ongoing program and thereby provide a base for the development of an advanced or postgraduate and research program.

The first Contract AID/afr-237 was signed December 15, 1964. It was superseded by Contract AID/afr-411 signed June 15, 1966. The first staff member arrived June 30, 1965. At the time the contract was terminated, June 30, 1971, ten contract staff had filled eight positions in the Faculty. The number of undergraduates had increased from 86 to 212. Staff numbers in the Faculty had increased from 19 to 43. By 1971, there were 53 postgraduate students registered for advanced degrees with 16 of them being supervised by West Virginia University contract staff. Contract staff members were also working on 27 research projects.



Above is the Administration Building and left is the Library without its new addition.

The instructional program for undergraduates had been revised and postgraduate programs involving both in-residence instruction and dissertation had been implemented. Contract staff responsibilities had gradually changed from that for purely undergraduate instruction to include constantly increasing responsibilities for postgraduate supervision and instruction and for research.

The demarcation of a specific time when a development project passes from one stage to another remains a moot point. The assistance program to the Faculty of Agriculture, Makerere University was deemed to have reached this point with the termination of Contract AID/afr-411, June 30, 1971, and the initiation of Contract AID/afr-798, July 1, 1971.

The report presented here provides a resume of the activities of the contractor in meeting the objectives of the initial program of assistance and in paving the way for the initiation of the second stage of the program.

## HISTORICAL BACKGROUND

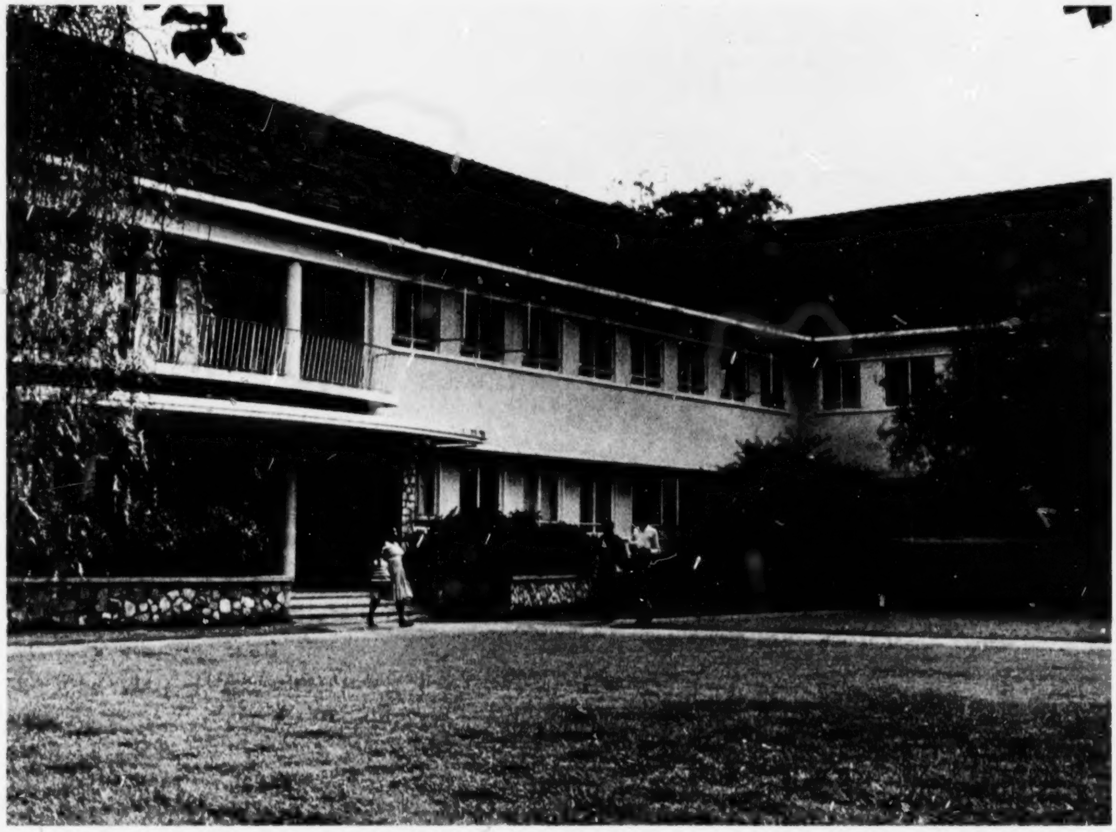
### Faculty of Agriculture-Makerere University

The development of Makerere University College started in 1921 when the Government of Uganda established a technical college on Makerere Hill on the outskirts of Kampala. A three-year diploma course in agriculture was added in 1922. In 1933, sciences were added to the curriculum and the course was extended to five years. Makerere College established a special relationship with the University of London in 1949, under which academic standards were set. The diploma course was upgraded to a B.Sc. (Agriculture) course in 1958, and the first B.Sc. (London) degrees were awarded in 1961.

In the early years, there was almost complete dependency on the Uganda Department of Agriculture for teachers and teaching facilities. Thus, the students spent one year of the course at the Serere Experiment Station, a period of residence at Bukalasa Experiment Station and made frequent trips to Kawanda Experiment Station. Teaching accommodations on campus were provided in one laboratory of the Biology Building. As the Biology Department expanded, agriculture instruction was moved to an unused portion of the Physics Building. In 1958, the faculty moved into its own building.

The program leading to the B.Sc. Degree in Agriculture was initiated in 1958 as a University of London Degree under special arrangements with the University of London. Candidates were accepted for both the degree and diploma course in 1958 but no further diploma candidates were accepted after that year. The first recipients of the B.Sc. Degree (Agriculture) graduated in 1961.

When the University of East Africa was formally organized in 1963, the arrangement with the University of London was terminated and the University of East Africa granted its own degree.



ABOVE: Faculty of Agriculture Building at Makerere.

LEFT: Student Dormitory on campus.

At the time of the initiation of this contract, the University of East Africa was composed of three University Colleges. The Faculty of Agriculture of the University was located at Makerere University College in Kampala, Uganda and served all three East African countries. Tanzania developed its own Faculty of Agriculture in connection with the University College, Dar es Salaam in 1969. Kenya had developed plans for a Faculty of Agriculture in the University College Nairobi. At the time, July 1970, that the University of East Africa was dissolved into three autonomous universities, each country had its own Faculty of Agriculture.

## Technical Assistance

Plans for the development of higher education in East Africa contained programs for the development of a University of East Africa with three constituent University Colleges. They were Makerere University College in Uganda, The University College Nairobi in Kenya and The University College, Dar es Salaam in Tanzania. The organization of the University of East Africa occurred as the three countries achieved independence. The Provisional Council of the University became the Council of the University of East Africa when the University was formally established on June 20, 1963.

Under the development plans of the University, each constituent University College was to have the basic faculties of Arts and Sciences as well as one or more professional faculties. The Faculty of Agriculture was to remain at Makerere. Because of the limited resources of the University it was inevitable that the old established faculties at Makerere would not, initially, receive the development support provided the younger faculties at the new University Colleges.

Professor Fergus Wilson, Dean of the Faculty of Agriculture believed strongly that the long range economic development of East Africa could not be attained unless there was a well-developed source of professional agriculturalists. He, therefore, with members of his faculty, prepared a developmental plan for the faculty that would assure a continued and increasing number of graduates in agriculture to meet the developmental needs of East Africa.

The Lake Como Conference in 1963 was held to bring together potential donors for the development of the University. Although the development plans for the faculty of Agriculture were not given high priority at the conference, the USAID, the Rockefeller Foundation and FAO/UNICEF agreed that agriculture should be given additional support over and above that committed to the University as a whole.

The development assistance provided by the Rockefeller Foundation and FAO/UNICEF are given in a previous progress report of this contract (IP-13).

The USAID entered into a Program Agreement with the University of East Africa in June, 1964, in which they promised support for the development of the Faculty of Agriculture. On the basis of this program agreement, a PIO/T was signed authorizing a contract with West Virginia University. The initial Contract, AID/afr-237 was signed in November, 1964. Under the terms of the contract, West Virginia University was to provide the services of a senior Agricultural Educator to work with the faculty and develop a long-range program of assistance and development. Dr. Newton M. Baughman, at that time stationed in Tanganyika under the terms of another contract, was requested by name to fill the initial position.

In March, 1965, under the terms of a short-term contract with the University of Minnesota, the USAID provided the services of two Agricultural Educators to visit the faculty to make a "Requirements Analysis" of the needs of the faculty in terms of physical facilities, staffing and long-range program development. The McFarland-Turner report was presented in April, 1965.

## CONTRACT OBJECTIVES

The original Contract AID/afr-237 provided a Senior Agricultural Education Advisor to the Makerere Faculty of Agriculture. The purpose of this position was to assist in assuring that the development of agricultural education in East Africa be planned in a cohesive, integrated fashion in order to further the raising of agricultural productivity in East Africa.

In addition to being appointed as senior member of 'the Faculty of Agriculture, he was: (1) A member of the Council Agricultural Education for East Africa; (2) West Virginia University's senior member of the diploma level schools in East Africa; (3) West Virginia University's representative to the Faculty of Agriculture; (4) Required to teach one or two specialized course.

Contract AID/afr-237 was superseded by AID/afr-411 Contract signed by West Virginia University on June 15, 1966. It initially provided for three additional staff members to the contract staff. They were: (1) a specialist in soil conservation and land use, (2) a specialist in pasture agronomy and range management, and (3) a specialist in animal and dairy husbandry.

Amendment No. 2 dated March 23, 1967, included a specific research component to the contract. Amendment No. 3 in August, 1967 added four additional staff members. These were: (1) a Horticulturalist, (2) a Poultry Specialist, (3) a Soil Microbiologist, and (4) a Livestock Economist.

The broad objectives of the Contract AID/afr-411 were:

1. The staff will initially teach undergraduate and eventually postgraduate courses in their respective fields. They must have the ability for both levels of instruction and to direct research projects of postgraduate students. They will introduce and teach

subject matter specialties in their respective fields, develop teaching outlines and techniques required and assist in overall curriculum development of the Faculty of Agriculture.

2. They must be well versed in programs of research as conducted in agricultural research stations in the United States. They will be expected to strengthen and orient the present agricultural research programs at the College to one which is adapted to East African conditions and related to ongoing programs in specialized research institutes.

The more specific objectives were related to increased manpower training at the B.Sc. or postgraduate levels as well as research improvement. They were stated as follows:

1. To assist the Faculty in increasing its student numbers to a total intake of 80-90 per year with an ultimate enrollment of 240-250 undergraduates.

2. To assist the Faculty in developing an in-resident postgraduate program for 50-60 students to increase postgraduate study and research programs.

3. To assist the Faculty in developing a research program to train postgraduate students to solve agricultural development problems in East Africa.

The stated objectives are concrete from the standpoint of measuring finite progress. The less concrete but perhaps more important objective was that of institution building. This is not easily measurable in finite terms. It is more subjective because it requires a recognition by individuals that the institution is a source of long-term guidance to its various clientele groups.

## CONTRACT IMPLEMENTATION

The objective of the contract was to strengthen the undergraduate teaching program and to begin improvements and strengthening of research and postgraduate training. The in-residence program of postgraduate training (which has increased greatly during the past six years) was suggested in the McFarland-Turner report and will be discussed in greater detail later in this report.

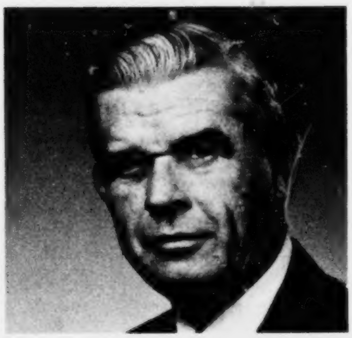
### West Virginia University Staff

Effective with the signing of Amendment 3 to Contract AID/afr-411 in August, 1967, there were eight established positions with the West Virginia University contract team in the Faculty of Agriculture. The last contract

## WEST VIRGINIA UNIVERSITY
## CONTRACT STAFF
## assigned to
## MAKERERE UNIVERSITY

O. J. Abbott
Poultry Specialist
10/67 - 6/71

Victor Amann
Livestock Prod. Econ.
6/69 - 6/71



Newton Baughman
Sen. Agr'l. Educator
7/65 - 1/68

Philip Kelly
An. Husbandry
6/67 - 7/69

Dean McIlroy
An. Husbandry
8/69 - 6/71

Paul Moe
Microbiologist
1/68 - 6/71

Ralph Nelson
Sen. Agr'l. Educator
11/67 - 12/70

Farrel Olsen
Crops Specialist
5/67 - 6/71

W. A. van Eck
Soils Specialist
9/66 - 6/71

Richard Wurster
Horticulturist
9/67 - 6/71

member arrived June 22, 1969. Although the initial and superseding contracts were in effect for six years, the contract was fully staffed for only two years. Over the life of the contract, ten staff members were involved. Only two of those who completed an assignment under the contract left the employment of West Virginia University. Dr. Kelly returned to his university in Nebraska and Dr. Olsen accepted a job on another assignment in Brazil.

Dr. Baughman returned to West Virginia University as Director of International Programs to replace Dr. Nelson who came to Makerere as Senior Agricultural Educator and Chief of Party. Dr. Nelson later returned to West Virginia University as Provost for Off-Campus Education, in which he retained the portfolio for international education. The staff members involved in the Makerere program are shown in Table 1.

## Faculty of Agriculture Staff

There has been a large increase in teaching and research staff members during the period of this contract. The national origin of the staff members has also changed markedly (see Table 2). In 1965, there were 19 staff members listed for the Faculty in three departments. Out of this list, ten members were British expatriates, three were Ugandans, and only one was American. The number of nationalities represented in the Faculty was seven; two of which were African (Kenyan and Ugandan).

In 1971, the total staff had increased to 43 senior members with an American Dean provided by the Rockefeller Foundation.

The staff has continued to be an international staff but the presence of Americans and Ugandans has increased noticeably. Table 2 presents a breakdown of total staff in the Faculty, by nationality, for 1965 and June, 1971. The large increase in the number of Ugandans is part of the objective to Ugandanize the staff. The early plan was to Africanize the staff with people from East Africa but after the breakup of the University of East Africa, the emphasis changed to Ugandanization.

Table 3 presents the staff list for the period 1965 and 1971. One can notice the sizable increase in numbers of staff members in Crop Science, Animal Science and Rural Economy and Extension Departments. The Department of Forestry was added during this period. This is now the only department which has students from several countries in Eastern Africa plus Nigeria.

## Government of Faculty

At the time the first contract member arrived at Makerere, the Faculty was divided into three departments--Agriculture, Agricultural Biology and Agricultural Chemistry. Each department was headed by a Professor who was supported by other staff members. The Faculty was headed by a Dean elected

Table 1. West Virginia University Contract Staff Members at Makerere.

| Established Post | Staff Member | Arrival Date | Departure Date |
|---|---|---|---|
| Senior Agricultural Educator | N. M. Baughman | 6-28-65 | 12-10-67 |
| | R. E. Nelson | 12-10-67 | 12-10-70 |
| Soil Conservationist | W. A. van Eck | 9-27-66 | 7-1-71 |
| Pasture Agronomist | F. J. Olsen | 6-4-67 | 5-25-71 |
| Animal Husbandry | P. Kelly | 6-18-67 | 6-18-69 |
| Horticulturist | R. T. Wurster* | 9-25-67 | |
| Animal Physiologist (Poultry) | O. J. Abbott* | 11-11-67 | |
| Soil Microbiologist | P. Moe* | 1-27-68 | |
| Livestock Economist | V. F. Amann** | 6-22-69 | |
| Animal Husbandry | D. McIlroy*** | 9-7-69 | 7-1-71 |

*Remain under new Contract AID/afr-798.

**Also appointed Chief of Party after the departure of Dr. R. E. Nelson.

***Took leave of absence from West Virginia University and returned to Makerere under Makerere contract, topped up by Rockefeller Foundation.

Table 2. Summary of Nationalities Represented on the Staff of Faculty of Agriculture, Makerere University.

June 30, 1965 and June 30, 1971

| Nationality | 1965 | 1971 |
|---|---|---|
| American | | |
| West Virginia University | 1 | 4 |
| Other | - | 4 |
| Asian | 2 | - |
| Australian | 1 | 1 |
| British | 10 | 9 |
| Canadian | - | 3 |
| Danish | - | 1 |
| Dutch | 1 | 1 |
| Kenyan | 1 | - |
| Norwegian | - | 8 |
| Ugandan | 3 | 12 |
| Total | 19 | 43 |

Table 3. Staff Members of the Faculty of Agriculture, Makerere University, 1965 and 1971.

| June 30, 1965 | | June 30, 1971 | |
|---|---|---|---|
| DEAN | | | |
| W. L. Fielding | (British) | John L. Nickel* | (American-Rockefeller) |
| DEPARTMENT OF AGRICULTURAL ENGINEERING AND LAND PLANNING | | | |
| W. H. Boshoff | (British) | W. H. Boshoff | (British) |
| B. N. Ghosh | (Asian) | G. Thierstein | (American-Rockefeller) |
| G. Hill | (British) | L. J. Clarke | (British) |
| | | E. W. Rugumayo | (Ugandan) |
| DEPARTMENT OF ANIMAL SCIENCE AND PRODUCTION | | | |
| R. S. Musangi | (Kenyan) | D. L. Gibson | (Canadian) |
| A. Schoen | (British) | J. D. Goodman | (American-Ford) |
| C. Jackson | (British) | O. J. Abbott | (American-WVU) |
| | | P. Stigsen | (Danish) |
| | | G. W. Kiwuwa | (Ugandan) |
| | | J. S. Mugerwa | (Ugandan) |
| | | D. Christenson | (Canadian) |
| | | H. H. Nickolson | (Canadian) |
| | | D. L. McIlroy | (American-Rockefeller) |
| DEPARTMENT OF CROP SCIENCE AND PRODUCTION | | | |
| W. L. Fielding | (British) | R. Holliday | (British) |
| A. S. MacDonald | (British) | O. M. Heide | (Norway) |
| C. L. Leakey | (British) | C. L. Leakey | (British) |
| W. B. Banage | (Ugandan) | R. T. Wurster | (American-WVU) |
| W. C. Block | (British) | G. Taksdal | (Norway) |
| | | R. W. Willey | (British) |
| | | J. C. Ddungu | (Ugandan) |
| | | J. Mukiibi | (Ugandan) |
| | | T. Khan | (British) |
| | | R. W. Radley | (British) |

Table 3. Staff Members of the Faculty of Agriculture, Makerere University, 1965 and 1971 (Continued)

| June 30, 1965 | | June 30, 1971 | |
|---|---|---|---|
| DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY | | | |
| N. M. Baughman | (American-WVU) | O. Gjems | (Norway) |
| H. F. Birch | (British) | P. G. Moe | (American-WVU) |
| P. Arman | (British) | E. J. Kakonge | (Ugandan) |
| I. J. Witham | (Australian) | I. J. Witham | (Australian) |
| | | B. Mukibi (Mrs.) | (Ugandan) |
| | | S. D. Keya | (Ugandan) |
| | | J. Zake | (Ugandan) |
| DEPARTMENT OF RURAL ECONOMY AND EXTENSION | | | |
| D. G. Belshaw | (British) | J. J. Oloya | (Ugandan) |
| M. Hall | (British) | V. F. Amann | (American-WVU) |
| | | E. R. Watts | (British) |
| | | J. P. Webster | (British) |
| | | J. De Woolf | (Dutch) |
| DEPARTMENT OF FORESTRY | | | |
| | | F. Jorgensen | (Norway) |
| | | A. Fitje | (Norway) |
| | | O. Haveraaen | (Norway) |
| | | L. Nagoda | (Norway) |
| | | R. Skaar | (Norway) |
| KABANYOLO UNIVERSITY FARM | | | |
| E. H. Barlow | (Ugandan) | E. H. Barlow | (Ugandan) |
| H. B. Ssewanyana | (Ugandan) | H. B. Ssewanyana | (Ugandan) |

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*Replaced by Professor Oland in July, 1971 (Norway).

by the Faculty Board (usually a Head of a Department) for a term of two years but he was eligible for reelection. His primary function was to chair Faculty Committee Meetings and carry out necessary administrative duties. He was also the official representative of the Faculty of Agriculture on University committees. There are several subcommittees of the Board which act as working parties in specific areas. Their ideas and proposals are presented to the Faculty Board for consideration and acceptance, modification or rejection. The Faculty Board meets at least twice per term. After final decisions are made by the Faculty Board, they are passed to the University Senate for final consideration.

The Requirements Analysis report recommended the provision of a full-time Academic Dean. In 1965, at the request of the then Dean, the Principal Makerere University College requested and received assistance from the Rockefeller Foundation to provide the services of a full-time Academic Dean as the Chief Administrative Officer of the Faculty. Professor John Nickel served in this capacity from August, 1966 until July, 1971 when he was succeeded by Professor K. Oland.

The Faculty was reorganized into five departments: Agricultural Engineering, Animal Science, Crop Science, Agricultural Chemistry and Rural Economy and Extension in 1966. These departments became operative on July 1, 1967. The Department of Forestry was added in 1970.

The primary decision-making body in the Faculty is the Faculty Board of Agriculture. Its membership consists of all academic and administrative members of the Faculty. In the early years of the Faculty with a small membership, decisions of the Board were made in full open discussion until a consensus of opinion was reached. However as the membership of the Board increased, the previously workable procedures became cumbersome and time consuming. Often decisions were made that were later found not to be in the best interests of all concerned.

The modus operandi of the Faculty Board of Agriculture has been revised. A committee procedure has been initiated resulting in more judicious decisions and an increased efficiency of operation. There are several subcommittees of the Board which act as working parties in specific areas. Their ideas and proposals are presented to the Faculty Board for consideration and acceptance, modification or rejection. The Faculty Board meets at least twice per term. After final decisions are made by the Faculty Board, they are passed to the University Senate for final consideration.

The primary committee within the Faculty is the Executive Committee. It is composed of the Head of each department, an elected member from the Faculty, and the Dean of the Faculty who is the Chairman. The Executive Committee makes decisions on administrative matters for the operation of the Faculty. These decisions are open for discussion at the Faculty Board. This committee also proposes matters of business for discussion by other committees and at the Faculty Board; reviews and advises on research within the Faculty; nominates members for all other Faculty committees; and solicits and allocates research funds. The Executive Committee meets twice a month. Dr. Philip Kelly, Head of the Department of Animal Science and Production was on this committee. Drs. Abbott, Moe and Amann participated in committee meetings when serving as Acting Heads of their departments at various times.

The Board of Postgraduate Studies is composed of the Dean as Chairman and eight members elected by the Faculty. This committee concerns itself with the postgraduate syllabus, regulations, and postgraduate student selection and performance. Dr. Paul Moe of the West Virginia University contract staff was on this Board during the 1968-69 school year. Dr. Ralph Nelson was on a Board subcommittee on postgraduate courses; Dr. Amann served on the Board for one year.

The Board of Undergraduate Studies is composed of the Dean and eight members elected by the Faculty Board. The Board's functions are to review undergraduate curriculum content, class scheduling, examination procedures, and to make recommendations on any changes to the Faculty Board. Members on this Board from West Virginia University contract staff were Drs. Ralph Nelson, Philip Kelly, V. F. Amann and Willem van Eck. The Board has a subcommittee on practical training of which Dr. Okra Abbott was a member.

The Farm Advisory Committee is composed of the Dean, Farm Manager, Assistant Farm Manager, five members of the Faculty Board, Head of the Department of Animal Science and Production, and the Head of the Department of Crop Science and Production who is Chairman. The functions of the committee are to:

1. Advise the Farm Manager on husbandry practices to be followed in the operation of the University Farm.

2. Review farm expenditures and revenues and to prepare budget estimates on farm operation for presentation to the Executive Committee.

Dr. Philip Kelly of the West Virginia University contract staff was on this committee during the 1968-69 school year. Several other West Virginia University staff members served on this committee; they included Drs. Amann, van Eck (Secretary), Moe and Olsen.

The Publication and Publicity Committee is composed of five members of the Faculty Board. Its function is to recommend policies and conduct business relative to official Faculty publications and public relations. Drs. Wurster, Abbott, and van Eck were West Virginia University contract members on this committee. Dr. Amann was Secretary to the committee for two years and as a member he edited and produced the brochure on Postgraduate Studies in the Faculty of Agriculture 1970-71. Dr. Farrel Olsen was Chairman of this committee during the 1970-71 academic year and a member in the previous year. This committee served a more important function before the initiation of the Research Committee. It will perhaps be abolished and its functions will be absorbed by the Research and Executive Committees.

Besides these standing committees, there is a Kabanyolo Open Day Committee which plans and executes the annual Kabanyolo Experiment Farm Open Day. Drs. Wurster, Nelson, and Abbott of the West Virginia University contract staff were members of this committee. Dr. Nelson was Chairman the first year Open Day was held.

The committee structure provides a process for decision making on matters which cut across academic discipline boundaries and affect the entire Faculty. Each department usually has a representative on each committee so that departmental concern on a subject can be channeled to the appropriate committee for detailed discussion and transmittal to the Faculty Board. The committee may also raise issues which have not been generated by departments.

Besides the Committee and Faculty Board system of decision making, the Faculty is divided into six subject matter departments. Intradepartmental decisions are made through department meetings. Matters concerning interdepartmental decision would be passed on to the Executive Committee or one of the other committees. There was at least one West Virginia University contract staff member in five out of the six departments. The Forestry Department is staffed completely from Norway.

There was also a request from the Government of Uganda for Makerere staff members to serve on subcommittees of the third Five-Year Plan working parties. Drs. Amann, Nelson and van Eck served on these subcommittees. Each presented at least one paper which was used in the development of the overall Plan for the next Five-Year Plan period. This provided an opportunity for Faculty members to have some close working relationship with the Government of Uganda ministerial personnel.

Another committee which was developed was the Staff-Student Consultative Committee. This was established in August, 1969 to establish improved communications and understanding between staff and students. Students were also asked to send representatives to all Faculty Committees where activities involve student interests, e.g., the Undergraduate and Postgraduate Committees.

The Faculty Research Committee was established in August, 1969 with the following terms of reference:

1. Formulate general research philosophy and policy and provide general guidelines on areas of research priority.

2. Encourage departments to seek the opinion of the committee on new research projects. Such submission of new research projects is not mandatory but would be advisable as it would engender discussion, produce valuable suggestions and encourage interdisciplinary cooperation. The committee should evolve into a recognized faculty body of reference on research whose recommendations should lend weight to requests for research funds.

3. Promote dissemination of information on progress of research project through:

    a. An annual printed research report. This will be a compilation of synopses of reports on research projects naming the investigators, the title of the project, the methods of investigation and the achievements so far. The period of reporting will be between April 1 and March 31. The report will be discussed by the Research Committee for constructive comments and suggestions particularly on methods. (See Appendix B for an example of these write ups.) This procedure was initiated in the Faculty by the West Virginia University contract staff on the request of USAID. This had not been practiced in the Faculty before the initiation of the Research Committee.

    b. Research colloquia which all postgraduate students should be encouraged to attend more frequently than in the past. To render the colloquia more instructive, attendants will visit the various research projects.

    c. Conferences and symposia.

4. To be responsible for nominating faculty representatives on research bodies in Uganda and East Africa.

## Instruction

### Undergraduate Instruction

One of the primary objectives of the contract was to assist in strengthening the undergraduate program of instruction of the Faculty. Included in this objective was the need to increase the number of graduates in agriculture to support the development of the agricultural sector of the economy in East Africa.

Table 4 shows that there was a steady increase in the numbers of undergraduate students in the Faculty over the period of time the contract was active. It further shows that the objective of increasing the intake

Table 4. Enrollment of B.Sc. Agriculture Students at Makerere, 1965-1971.

| Class | 1965-66 | 1966-67 | 1967-68 | 1968-69 | 1969-70 | 1970-71 | 1971-72 |
|---|---|---|---|---|---|---|---|
| Year I | 40 | 61 | 66 | 79 | 76 | 65 | 77 |
| Year II | 27 | 37 | 48 | 60 | 80 | 72 | 63 |
| Year III | 19 | 23 | 36 | 47 | 59 | 80 | 72 |
| Total | 86 | 121 | 150 | 186 | 215 | 217 | 212 |

of first year students to 80 per annum was almost reached. If forestry students are included (which they should) the objective was met. There were 22 forestry students in the 1970-71 class and 24 in the 1971-72 class bringing the total number of first-year students in these classes to 87 and 101, respectively.

The activation of Faculties of Agriculture in Tanzania and Kenya had some effect on Agriculture enrollments in 1969-70 and 1970-71. There were few students from these countries entering the Faculty in those years. The increased need for agriculturalists in Uganda, however, resulted in an increased intake in the 1971-72 academic year.

The number of graduates has been mentioned earlier but the classification of the degrees of graduating classes is also important. Table 5 presents the degree classification over the past four years.

Table 5. B.Sc. Degree Graduates and Classification of Degrees
Faculty of Agriculture 1968-1971

| Degree Classification | 1968 | 1969 | 1970 | 1971 |
|---|---|---|---|---|
| First Class Honors | 0 | 1 | 0 | 2 |
| Upper Second | 3 | 9 | 10 | 15 |
| Lower Second | 23 | 23 | 36 | 50 |
| Pass | 10 | 12 | 6 | 13 |
| Referred | 0 | 1 | 6 | 0 |
| Pass Contingent on Special Project | 0 | 1 | 0 | 0 |
| Fail | 0 | 0 | 1 | 0 |
| Total Degrees | 36 | 47 | 58 | 80 |

Table 6. Undergraduate Teaching Load of West Virginia University Contract Staff Faculty of Agriculture 1967-1971

| Staff Member | Lecture Hours | Seminar Hours | Class Practical Hours | Excursions and Field Trips Number |
|---|---|---|---|---|
| Teaching Load 1967-68 Academic Year | | | | |
| First Term: | | | | |
| W. A. van Eck | 18 | -- | 27 | |
| Philip Kelly | 9 | 4 | -- | |
| Richard Wurster | 5 | -- | 10 | |
| Newton Baughman | 11 | -- | -- | |
| Second Term: | | | | |
| W. A. van Eck | 7 | -- | 42 | |
| Philip Kelly | 7 | 4 | -- | |
| Richard Wurster | 5 | -- | 10 | |
| Third Term: | | | | |
| Philip Kelly | 8 | -- | 10 | |
| Okra Abbott | 5 | -- | -- | |
| Farrel Olsen | 6 | -- | 12 | |
| Richard Wurster | 5 | -- | 5 | |
| Teaching Load, West Virginia University Contract Staff, 1968-69* | | | | |
| First Term: | | | | |
| Philip Kelly | 40 | 30 | -- | -- |
| Farrel Olsen | 11 | -- | 18 | 6 |
| P. G. Moe | 30 | 20 | 60 | -- |
| Okra Abbott | 24 | -- | 30 | -- |
| Ralph Nelson | -- | 16 | -- | -- |
| W. A. van Eck | 4 | 14 | 16 | -- |
| Richard Wurster | No teaching | | | |
| Second Term: | | | | |
| Philip Kelly | 7 | 10 | 30 | 5 |
| Farrel Olsen | No teaching | | | |
| P. G. Moe | 10 | 30 | 60 | -- |
| O. J. Abbott | 14 | -- | -- | 4 |
| Ralph Nelson | -- | 32 | -- | -- |
| W. A. van Eck | 8 | -- | 12 | -- |
| Richard Wurster | 8 | -- | 12 | -- |

Table 6. Undergraduate Teaching Load of West Virginia University Contract Staff Faculty of Agriculture 1967-1971 (Continued)

| Staff Member | Lecture Hours | Seminar Hours | Class Practical Hours | Excursions and Field Trips Number |
|---|---|---|---|---|
| Third Term: | | | | |
| Philip Kelly | 17 | -- | -- | 3 |
| Farrel Olsen | 6 | -- | 18 | -- |
| P. G. Moe | 5 | -- | -- | -- |
| Okra Abbott | 12 | -- | -- | 2 |
| Ralph Nelson | No teaching | | | |
| W. A. van Eck | 7 | 21 | 21 | -- |
| Richard Wurster | -- | 6 | -- | -- |
| Teaching Load, West Virginia University Contract Staff, 1969-70 | | | | |
| First Term: | | | | |
| Okra Abbott | 21 | -- | 15 | -- |
| V. F. Amann | 21 | 50 | -- | -- |
| Ralph Nelson | -- | 20 | -- | -- |
| Second Term: | | | | |
| Okra Abbott | 4 | 4 | -- | -- |
| V. F. Amann | 20 | 12 | -- | -- |
| D. L. McIlroy | 9 | -- | -- | -- |
| Ralph Nelson | -- | 20 | -- | -- |
| Farrel Olsen | 10 | -- | 12 | -- |
| W. A. van Eck | 30 | 10 | 114 | 2 |
| Third Term: | | | | |
| V. F. Amann | 24 | 12 | -- | 3 |
| D. L. McIlroy | 16 | -- | -- | -- |
| P. G. Moe | 40 | -- | 180 | -- |
| Farrel Olsen | 10 | 24 | 30 | -- |
| W. A. van Eck | 4 | 10 | 24 | -- |
| Richard Wurster | 5 | 24 | 6 | -- |
| Teaching Load, West Virginia University Contract Staff, 1970-71 | | | | |
| First Term: | | | | |
| V. F. Amann | 25 | 60 | -- | -- |
| Okra Abbott | 10 | 10 | 42 | -- |
| D. L. McIlroy | 20 | -- | -- | -- |

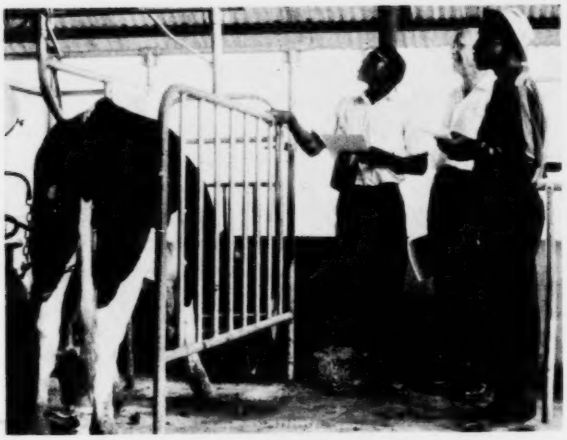
Table 6. Undergraduate Teaching Load of West Virginia University Contract Staff Faculty of Agriculture 1967-1971 (Continued)

| Staff Member | Lecture Hours | Seminar Hours | Class Practical Hours | Excursions and Field Trips Number |
|---|---|---|---|---|
| Ralph Nelson | -- | 20 | -- | -- |
| Farrel Olsen | 10 | 30 | -- | 2 |
| Richard Wurster | -- | 24 | -- | -- |
| W. A. van Eck | 10 | 20 | -- | -- |
| Second Term: | | | | |
| Okra Abbott | 9 | -- | -- | -- |
| V. F. Amann | -- | 27 | -- | -- |
| Ralph Nelson | 27 | -- | -- | -- |
| Richard Wurster | 12 | -- | 18 | -- |
| W. A. van Eck | 27 | 27 | 54 | -- |
| Third Term: | | | | |
| V. F. Amann | 10 | 6 | -- | -- |
| P. G. Moe | 21 | -- | 60 | -- |
| Richard Wurster | 8 | 20 | 9 | -- |
| W. A. van Eck | 10 | 6 | 8 | -- |
| D. L. McIlroy | 18 | -- | -- | -- |

*In addition, all staff, except Drs. Nelson and Moe, taught practical skills during the vacation period practicals.

The data presented in Table 6 gives an indication of the chronological increase in teaching load carried by West Virginia University staff members. This occurred even though the total number of staff members was increasing and student numbers were beginning to stabilize. Dr. Amann was involved in teaching students outside the Faculty of Agriculture because the Social Science students can choose agriculture as an option and students come into the Rural Economy Department for courses. The usual number has averaged about 45 students. This option is becoming more popular and will increase the teaching load in the future. He also was required to teach the Farm Management course in the absence of the lecturer in that course who is studying for a Ph.D. in the United States.

Dr. Philip Kelly spent many hours with animal husbandry students on practicals and field observations.



Dr. Richard Wurster and students spend much time in the field and greenhouse making observations on horticultural research.

## Syllabus Revision and Development

When the first contract staff member arrived, the faculty instruction program followed the European tradition. It provided a uniform course and subject matter was not divided into discrete courses. The program of instruction contained series of lectures and laboratory periods which attempted to integrate the entire subject of agriculture into one course.

The first year was divided into science subjects. Little time, approximately one-fourth, was devoted to agriculture. Students were admitted to the agricultural portion of the course given in the second and third years if they passed subject matter in the first year.

The examination leading to successful completion of the degree was divided into two parts. The first was given at the end of the second year, and the second part at the end of the third year. The examinations were set in a broad setting which covered all subjects studied by students. The comprehensive nature of the examinations was theoretically a method of forcing students to prepare and understand the interrelationships of subject matter they had studied.

Students were required to pass every examination in order to be admitted into next year's class or to be awarded a degree. Students failing an examination were "referred" and were required to take a make-up examination. If he failed more than one examination, he was required to repeat the entire year or be released from studies.

The final year papers were read and marked by the staff at Makerere plus external examiners. The marks are then presented to an examiners' meeting. This is made up of the Faculty Board plus the external examiners, where they are finalized. Some adjustments are permitted in this meeting and the classification of degrees is agreed upon. This system of final examination marking and degree classification still exists in the Faculty.

The number of students that could be admitted each year was limited by the number that could be seated at one time in a lecture theater or instructed at one time in a laboratory or practical section. "The Requirements Analysis Report" made by McFarland and Turner in 1965 gave an illustration of how the number of students could be increased two or three fold utilizing the same physical facilities by "double sectioning". The revised development plan of the faculty prepared in 1966 (Dr. Baughman was a member of the committee that prepared this development plan) included a projected increase in student numbers based, in part, on this report.

The development plan of the Faculty was the basic document for requesting additional assistance from the USAID. Subsequent amendments and revisions of the contract with West Virginia University resulted from the acceptance by the USAID of the substance of this document.

Through the life of the contract, the Faculty has engaged in a series of exercises in curriculum revision.

## A. First Curriculum Revision

The first curriculum revision occurred in 1966. A series of papers prepared as a basis of this revision are given in the first progress report of the Contractor, IP-13, Office of International Programs, West Virginia University, July, 1966. In this syllabus the Faculty approved specialization in the second and third years of the degree course. Lectures were regularized with attempts to reduce undue duplication of subject matter. Attention was given to the sequence of subject matter presentation and the examination procedures were revised.

## B. Second Curriculum Revision

In 1968, a revised syllabus was approved by the Faculty Board at the November 8 meeting. It was later approved by the Academic Board and University Senate. The influence of the West Virginia University contract staff members in the formulation of the new syllabus and examination scheme was considerable. Dr. Kelly traveled to England and the Netherlands to study the syllabi of the facilities of agriculture in those countries. His report was very useful in ascertaining the educational trends in those countries and in making a cooperative study of syllabus content, which was used as a basis for developing the revised syllabus for the Faculty at Makerere. Dr. Kelly was also Chairman of a Subcommittee on Curriculum Evaluation. This Subcommittee compiled a list of the number and content of every lecture and practical given in the present syllabus. These were compiled by departments which were a necessary prerequisite to developing course units. Dr. Kelly was also a member of the Board of Undergraduate Studies from its inception. Dr. van Eck was also a charter member of the Board. The 1968 syllabus revision included the following changes:

1. Subject matter taught by the Faculty was divided into "course units". Each course unit consists of 35-40 lecture equivalent hours in which one lecture hour is equivalent to one hour of seminar, two hours of laboratory and/or practical and one excursion. Course material is aggregated in multiples

of half course units. The listing of the course includes a course description.

2. Courses are numbered according to the year in which they are taken by the student. All first-year courses are numbered in the 100's, second-year courses in the 200's, etc. All course numbers are preceded by letters designating the department which has the responsibility for teaching the course if it is a single department course, or coordinating the instruction if it is a multidisciplinary course.

3. The syllabus provides for three mild options in the third year. These options are General Management, Animal Science and Crop Science.

4. The syllabus provides for 1 1/2 course units of electives in the third year.

5. Seven weeks of practical training at the University Kabanyolo Farm during the vacation periods of the second year has been added.

The course unit system is considered an improvement over the previous system for the following reasons:

1. It gives a clearer picture of what is being taught and the number of lectures, laboratory periods, practicals, seminars and excursions which make up each course.

2. It minimized duplication of material taught and identified knowledge gaps in the 3-year syllabus.

3. It has made it easier to add new options such as Forestry, Agricultural Education, etc., and integrate these specialized options into the syllabus.

4. It makes it easier to develop inter-Faculty programs of instruction.

5. It has made it possible to transfer academic credits to and from other institutions which follow a similar course unit system.

6. The graduate will have a greater understanding of the practical and applied aspects of agriculture.

The 3-year syllabus approved in 1967 is included in Appendix M.

## New Examination Scheme

In conjunction with the new syllabus, the Faculty Board, Academic Board and University Senate also approved a new examination scheme. Under the old examination scheme, the students sat seven 3-hour examinations and two 2-hour practical exams at the end of the first year's study; seven 3-hour examinations after the second year; and five 3-hour examinations at the termination of the third year.

The new examination scheme for a Bachelor of Science in Agriculture was inaugurated in two stages.

### Stage 1

Course unit examinations during the first year in which a satisfactory performance will qualify a student to enter the second year.

### Stage 2

Final examinations held at the end of the second and third years, in conjunction with continuous assessment, will decide both whether a degree is awarded and the classification of the degree.

## First-Year Course Unit Examinations

1. All first-year course unit examinations are internal Faculty examinations. The questions are set and graded by the lecturer(s) responsible for the course. They include factual, problem solving and integrative types of questions. They may also test the students' practical ability.

2. Up to one-third of the marks awarded for any course unit may be based on continuous assessment.

3. Course units are examined as soon as possible after the unit has been completed.

4. Course unit examinations are one hour long for a half unit, two hours for a full unit, and three hours duration for a one and one-half unit course.

5. Course grades are calculated as follows:

| | |
|---|---|
| Excellent | 5 |
| Very Good | 4 |
| Good | 3 |
| Fair | 2 |
| Poor (compensable/pass) | 1 |
| Fail | 0 |

6. Aggregate course grades are calculated by multiplying the course grade by the course unit weighing and adding the products.

7. A student must obtain an aggregate course grade of 26 or more (based on 13 course units) to be considered for entry into the second year. If the student's aggregate course grade is less than 26, he shall be discontinued but may be reinstated on recommendation of the Faculty Board.

8. A student who obtains an aggregate course grade of 26 or more will normally be required to resit all failed courses, although a student with an aggregate course grade of 28 or more will be permitted a failure in one course.

9. A student who is reexamined in a failed course should receive a grade of one or more before being permitted to commence the second year. A student who is referred in two or more courses, and is able to raise his aggregate course grade to 28 or more, will be permitted a failure in one course.

10. A student who does not pass his referred examination, or who does not meet the requirement in "9" above, will normally be asked to repeat the year.

11. Referred examinations will be held before the beginning of the first term of the second year.

## Final Examinations for the B.Sc. (Agriculture)

1. The final examinations in Agriculture will be composed of the following elements:

    a. Written final papers taken at the end of the second or third years.

    b. Continuous assessment.

    c. A special project conducted in the long vacation between the second and third years.

    d. An assessment of a farm management case study conducted during the third year.

    e. A satisfactory report on performance in practical skills acquired during the second year.

2. At the end of the second year, students will sit 3-hour final papers as follows:

| | Management & Extension Option | Animal Option | Crop Option |
|---|---|---|---|
| Animal Science and Production | 2 | 4 | 2 |
| Crop Science and Production | 3 | 2 | 4 |
| Rural Economics and Extension | 3 | 2 | 3 |

AC 301, 302, AE 301 and CS 204 will be examined in Crop Production papers.

AC 303 and AE 302 will be examined in Animal Production papers.

3. Continuous assessment, based on unit examinations, assessment of practicals, essays, seminars, etc., will count for one-third of the possible marks in all final examination papers. At the termination of each course unit, the lecturer(s) responsible for the unit will submit, through their Head of Department, an assessment of the student's performance in that unit to the Faculty Office. This assessment will be based on the same grading standards as used in the final papers, i.e.:

| | |
|---|---|
| Excellent | 70%+ |
| Very Good | 60% - 69.9% |
| Good | 50% - 59.9% |
| Pass | 40% - 49.9% |
| Fail | Below 40% |

4. The final paper mark will be from a total of 150 marks, of which a possible 100 marks will be allocated to the final paper, and a possible 50 allocated to continuous assessment of the courses making up that paper. The continuous assessment mark will be the weighed average of the course making up that paper.

5. A student must satisfy the examiners in all subjects and in the special project plus case study before being awarded a degree.

6. The pass mark for a subject will be an average of 40% or 60 marks of the papers making up that subject.

7. An average of below 35% in any subject will be considered a clear failure in that subject.

8. Compensation will be allowed between subjects for one subject only provided the mark in that subject is 35% or above, or that a formula of two marks above 40% in other subjects for each mark compensated is followed.

9. A student may be referred in one subject only, either at the end of the second or third year.

10. External examiners will check all papers examined and may also, on request, check any unit examinations used for the purpose of continuous assessment.

11. The final paper mark should be agreed to by both External and Internal Examiners, although the mark of the External Examiner will normally prevail. Should there be serious disagreement, then Faculty Board will be asked to adjudicate.

12. Classification of the degree will be based as follows:

| | |
|---|---|
| Best 9 of all papers at 150 possible marks each | 1350 |
| Special Project and Case Study | 100 |
| Assessment of Elective Courses | 50 |
| | 1500 |

The total number of marks will be divided by 15 and the degree classified as follows:

| | |
|---|---|
| First Class | 70%+ |
| Upper Second | 60% - 69.9% |
| Lower Second | 50% - 59.9% |
| Pass | 40% - 49.9% |

The Faculty Board may, under special circumstances, recommend that students obtaining marks of 65-69.9%, 55-59.9% or 45-49% be awarded a first, upper second or lower second degree, respectively.

13. A student who repeats his final year will, if successful, be normally awarded an unclassified degree.

The new examination scheme is considered superior to its predecessor because:

a. The continuous assessment component of the scheme acts as a progress report to the student so that he may periodically evaluate his academic performance.

b. The continuous assessments provide a feedback to the instructor so he can evaluate the effectiveness of his instruction.

c. The final grade is based on numerous exams given throughout the year so it should be more representative of the student's performance.

## Syllabus Options

The introduction of options was included in the syllabus after much discussion within the Faculty and with potential employers of agricultural graduates. It was decided that the existing syllabus, in which all students followed either Crop or Animal options for the final two years of B.Sc. (Agriculture) course was not well suited to the current East African manpower needs. The major faults with the curriculum were:

1. It represents too high a degree of specialization for most positions open to agriculture graduates.
2. There is no option aimed specifically at training the general Agriculture Officer
3. The end of the first year is too early for a student to decide on an option.

The 1968 syllabus was basically a single, general course with opportunities for students to choose one of three broad areas of interest in the final year. It was not designed to produce specialists but merely to permit students to express individuality and to allow teaching in one chosen area to be in enough depth to provide the experience of scholarship.

## Course Units

The syllabus has divided the entire course into relatively small, discrete parcels, called "course units". These discrete units have the following advantages:

1. The clearer definition of what is taught and for how long in each subject. This will contribute to continuity of curriculum content in spite of staff changes and will prevent unnecessary overlap in teaching.
2. The ease with which new options (e.g., Forestry or Agricultural Education) can be added or more specialization achieved, as needed, by adding new units and combining them with these "building blocks" in the desired combinations.

3. This system lends itself to possible developments of inter-Faculty offerings, such as the existing 3.2.2 in the Rural Economy, and for e.g., future 3.2.2 degrees in Agricultural Science and Agricultural Education.

The new course unit system and examination scheme was put into practice during the 1969-70 academic year. The students and staff responded favorably to the new system and it is being continued. The Visitation Committee to Makerere University College recommended that "a credit system for all courses be implemented in the University so that a student who has studied any subject to a certain level elsewhere is not required to repeat what he has already covered". They also recommend that "every department should be required by regulation, to continually assess the performance of a student throughout his career at the University" and "that in every department credit of up to 35 per cent of the final examination marks should be given for progress and/or course work, tests and examinations". These recommendations must have been based on the experience within the Faculty of Agriculture as this Faculty pioneered the course unit system and new examination system at Makerere.

## C. Third Curriculum Revision (1971)

It was decided that after the new syllabus which included course units, options and continuous assessment has been in use for two years, an evaluation should be undertaken. The Board of Undergraduate Studies under the Chairmanship of Dr. John Mugerwa (Ph.D. Ohio State University) made the proposed changes, which were accepted by the Faculty Board meeting on June 8, 1971.

West Virginia University staff members which served on the Board during the revision were Drs. Moe, van Eck and Amann. Dr. Amann presented a paper on the proposed changes for the Department of Rural Economy and Extension (Appendix N). The request was accepted in general, but the proposed increase in course units was not fully accepted. However, the portion that was accepted was more adequate to fill the need of the department than what was formerly offered.

Since the first revised syllabus was accepted, several changes had come about in the Faculty. A new Forestry Department was inaugurated in June, 1970, and 22 students from five countries were enrolled in the first class. Many of the courses offered to the forestry students are held in common with the agriculture students.

The new syllabus also provided for a fourth option for students reading for the B.Sc. (Agriculture). These options are:

a. Crop Production
b. Animal Production
c. Management and Extension
d. Education (for students taking a concurrent diploma in Education only)

The syllabus for the B.Sc. (Forestry) puts emphasis on that subject, but some elements of the management of other natural resources are included in order to enable the student to evaluate in a competent manner the use of land, labor and capital for forestry in relation to other types of resource use.

A comparison prefixes represent the following departments:

| | |
|---|---|
| AC | Soil Science and Agricultural Chemistry |
| AE | Agricultural Engineering and Land Planning |
| AS | Animal Science and Production |
| CS | Crop Science and Production |
| FO | Forestry |
| RE | Rural Economy and Extension |

| Course Number | Year I Course Title | Course Units | | |
|---|---|---|---|---|
| | | | 1971 Syllabus | |
| | | 1968 | Agric. | Forestry |
| AC 101 | Inorganic and Physical Chemistry | 1 | NA | NA |
| AC 102 | Agricultural Chemistry | 1 | NA | NA |
| AC 101 | Biochemistry I | NA | 1 | -- |
| AC 102 | Biochemistry II | NA | 1 1/2 | -- |
| AC 103 | Biochemistry III | 1 | -- | 1 1/2 |
| AC 103<br>(1971 AC 104) | Microbiology | 1 | 1/2 | -- |
| AC 105 | Soil Science I | NA | 1 | 1 |
| AE 101 | Agricultural Engineering | 1 1/2 | 1 | -- |
| AS 101 | Zoology | 1 1/2 | 1 1/2 | -- |
| AS 102 | Animal Physiology | NA | 1/2 | -- |
| CS 101 | Botany | 1 | 1 1/2 | 1 |
| CS 102 | Genetics | 1/2 | 1/2 | 1/2 |
| CS 103 | Plant Physiology | 1 | 1 | 1 |
| CS 104 | Agronomy | 1 | 1 | 1 |
| CS 105 | Ecology | 1/2 | NA | NA |
| CS 106 | Entomology | 1/2 | NA | NA |
| FO 101 | Forest Economics | NA | -- | 1 1/2 |
| FO 102 | Forest Biology | NA | -- | 1 1/2 |
| FO 103 | Forest Engineering I | NA | -- | 1 |
| FO 104 | Mathematical Statistics | NA | -- | 1 1/2 |
| FO 105 | Wood Utilization I | NA | -- | 1 |
| RE 101 | Introduction to Agricultural Economics | 1 | 1 1/2 | -- |
| RE 102 | Introduction to Statistics | NA | 1/2 | -- |
| RE 102 | Agricultural Economics | 1 1/2 | NA | NA |
| | | 13 | 14 | 12 1/2 |

|  |  | Course Units |  |  |
|---|---|---|---|---|
|  |  |  | 1971 Syllabus |  |
| Course Number | Year II Course Title | 1968 | Agric. | Forestry |
| AC 201 | Biochemistry | 1 | NA | NA |
| AC 201 | Soil Science II | NA | 1 | 1 |
| AC 202 | Soil Science III | NA | 1 | -- |
| AC 202 | Geology and Soil Formation | 1/2 | NA | NA |
| AC 203 | Soil Physics | 1/2 | NA | NA |
| AC 204 | Soil Chemistry & Fertility | 1 | NA | NA |
| AE 201 | Soil/Water Conservation Engr. | 1 | 1 | 1 |
| AE 202 | Farm Mechanization | 1 | 1 | -- |
| AS 201 | Feeds and Feeding | 1 | NA | NA |
| AS 201 | Animal Nutrition I | NA | 1 | -- |
| AS 202 | Animal Physiology | 1/2 | NA | NA |
| AS 202 | Livestock Management | NA | 1 | -- |
| AS 203 | Livestock Management | 1 | NA | NA |
| AS 203 | Poultry Management | NA | 1/2 | -- |
| CS 201 | Agronomy II (Annual/Crops) | 1 | 1 | -- |
| CS 202 | Agronomy III (Pasture Agronomy) | 1/2 | NA | NA |
| CS 202 | Principles of Crop Production (changed to CS 203 in 1971) | 1/2 | 1 1/2 | -- |
| CS 203 | Applied Statistics (changed to CS 204 in 1971) | 1 | 1 | -- |
| FO 201 | Forestry Biology II | NA | -- | 2 |
| FO 202 | Forest Mensuration | NA | -- | 1 1/2 |
| FO 203 | Management Planning | NA | -- | 1 |
| FO 204 | Forest Engineering II | NA | -- | 2 |
| FO 205 | Forest Economics II | NA | -- | 2 |
| FO 206 | Wood Utilization II | NA | -- | 2 |
| FO 207 | Wildlife Ecology | NA | -- | 1 |
| RE 201 | Production Economics and Farm Management | 1 1/2 | 2 | -- |
| RE 202 | Agricultural Extension and Rural Sociology | 1 1/2 | 1 1/2 | -- |
|  | Total | 14 | 13 1/2 | 13 1/2 |
|  | Vacation Practical Training | 2 1/2 | NA | NA |

| Course Number | Year III Course Title | Course Units | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1968 (Options) | | | 1971 (Options) | | | | |
| | | M | A | C | E | M | A | C | For |
| AC 301 | Soils and Fertilizers | ½ | - | ½ | NA | NA | NA | NA | NA |
| AC 302 | Advanced Soil Science | - | - | ½ | NA | NA | NA | NA | NA |
| AC 303 | Animal Nutrition and Biocehmistry | - | 1 | - | NA | NA | NA | NA | NA |
| AE 301 | Farm Mechanization--Crops | ½ | - | ½ | NA | NA | NA | NA | NA |
| AE 301 | Farm Structures and Farm Mechanization | NA | NA | NA | ½ | ½ | ½ | ½ | - |
| AE 302 | Farm Mechanization - Aminals | - | ½ | - | NA | NA | NA | NA | NA |
| AS 301 | Feeds and Feeding II | ½ | ½ | - | NA | NA | Na | NA | NA |
| AS 301 | Animal Nutrition II | NA | NA | NA | ½ | ½ | ½ | - | - |
| AS 302 | Animal Breeding | - | 1 | - | - | - | 1 | - | - |
| AS 303 | Reproduction Physiology & Animal Industry | - | ½ | - | NA | NA | NA | NA | NA |
| AS 303 | Animal Physiology II | NA | NA | NA | 1 | - | 1 | - | - |
| AS 304 | Dairy Management | ½ | ½ | ½ | ½ | ½ | ½ | ½ | - |
| AS 305 | Processing of Agricultural Products | 1 | 1 | 1 | - | 1 | 1 | 1 | - |
| AS 306 | Poultry Management | ½ | ½ | - | NA | NA | NA | NA | NA |
| AS 306 | Human Nutrition | NA | NA | NA | ½ | ½ | - | - | - |
| AS 307 | Animal Health and Hygiene | - | 1 | - | 1 | - | 1 | - | - |
| AS 308 | Special Topics in Animal Production | NA | NA | NA | - | - | ½ | - | - |
| CS 301 | Agronomy III (Horticulture in 1971) | ½ | ½ | ½ | ½ | ½ | ½ | ½ | - |
| CS 302 | Agronomy IV (Perennial Crops in 1971) | ½ | ½ | ½ | 1 | 1 | 1 | 1 | - |
| CS 303 | Crop Improvement | 1 | - | 1 | NA | NA | NA | NA | NA |
| CS 303 | Agronomy V (Pastures) | NA | NA | NA | ½ | ½ | ½ | ½ | - |
| CS 304 | Economic Botany and Crop Physiology | - | - | 1 | 1 | - | - | 1 | - |
| CS 305 | Plant Pathology | - | - | 1 | - | - | - | 1 | - |
| CS 306 | Crop Pests (Plant Pests 1971) | - | - | 1 | - | - | - | 1 | - |
| CS 307 | Crop Improvement | NA | NA | NA | - | 1 | - | 1 | - |
| FO 301 | Forest Protection | NA | NA | NA | - | - | - | - | 1½ |
| FO 302 | Wood Utilization III | NA | NA | NA | - | - | - | - | 1 |
| FO 303 | Forest Management and Administration | NA | NA | NA | - | - | - | - | 2 |
| FO 304 | Forest Engineering III | NA | NA | NA | - | - | - | - | 1 |
| FO 305 | Land Use Law and Policy | NA | NA | NA | - | - | - | - | 1½ |
| RE 301 | Agricultural Production and Marketing Program | 1½ | 1½ | 1½ | NA | NA | NA | NA | NA |
| RE 301 | Agricultural Development | NA | NA | NA | 1 | 1 | 1 | 1 | - |

| Course Number | Year III Course Title | Course Units | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1968 (Options) | | | 1971 (Options) | | | | |
| | | M | A | C | E | M | A | C | For |
| RE 302 | Agricultural Program Implementation | 1½ | - | - | NA | NA | NA | NA | NA |
| RE 302 | Agricultural Marketing | NA | NA | NA | 1 | 1 | 1 | 1 | - |
| RE 303 | Socio-Enonomic Surveys | ½ | - | - | NA | NA | NA | NA | NA |
| RE 303 | Agricultural Administration & Plan Implementation | NA | NA | NA | - | 1 | - | - | - |
| RE 304 | Agricultural Cooperatives and Credit | NA | NA | NA | 1 | 1 | ½ | ½ | - |
| RE 305 | Special Topics in Rural Development | NA | NA | NA | - | ½ | - | - | - |
| | Electives | 1½ | 1½ | 1½ | NA | NA | NA | NA | NA |
| | Total | 10½ | 10½ | 10½ | 10 | 10½ | 10½ | 10½ | 7 |
| | Field Training | NA | NA | NA | 2 | 2 | 2 | 2 | 5 |
| | Total Course Units in Degree Program | 40 | 40 | 40 | 39½ | 40 | 40 | 40 | 38 |

NOTE: (1) NA means the course was not available at that time or under that title and course number.
Some courses were split into new courses or moved to different time in the curriculum.

(2) The options in Year III are:
M = Management and Extension
A = Animal Production
C = Crop Production
E = Education
For = Forestry

## Course Descriptions 1971 Syllabus

### First Year

AC 101 Biochemistry I (1 Course Unit)

Equilibria, acids, bases, buffers and indicators. Surface chemistry. Chromatography. Colloids. Important reaction types in biochemistry. Chemistry and function of biologically important compounds including carbohydrates, lipids, amino acids, proteins, nucleotides, nucleic acids and lignin.

AC 102 Biochemistry II (1 1/2 Course Unit)

Reaction kinetics. Enzymology. Co-enzymes. Biological energetics. General metabolism of carbohydrates, lipids, amino acid proteins and nucleic acids. Metabolic control mechanisms. Comparative metabolism of different animal tissues. Mineral and trace element metabolism. Plant biochemistry including the light reaction in photosynthesis; synthesis, transport and storage of carbohydrate; nitrate reduction and nitrogen fixation; amino acid synthesis; chemistry of cell wall components. Selective toxicity--general mechanisms of action of selectively toxic agents used in agriculture.

AC 103 Biochemistry (Forestry) (1 1/2 Course Units)

Equilibria. Acids, bases, buffers and indicators. Surface chemistry. Chromatography. Colloids. Important reaction types in biochemistry. Chemistry and functions of biologically important compounds including carbohydrates, lipids, amino acids, proteins and nucleotides. Gross chemical composition of wood. Chemistry of plant cell wall components. Chemistry and functions of extraneous components of wood. Proximate analysis of wood. Enzymology, biological energetics and elementary metabolism of carbohydrates, lipids and amino acids in the plant.

AC 104 Microbiology (1/2 Course Unit)

A study of bacteria, actinomycetes, fungi and lower algae. Elementary principles of the ecology, physiology and classification of microorganisms important in agriculture.

AC 105 Soil Science I (1 Course Unit)

Elementary geology, rock minerals and weathering. Factors influencing soil formation and development of soil profiles. Criteria used for soil classification. Important soil types in East Africa.

AE 101* Agricultural Engineering (1 Course Unit)

Engineering materials; including iron, steel, wood, plastics and concrete. Fundamental mechanical elements and principles. Power unit principles and tractor types. Utilization of electricity on the farm. An introduction to farm machinery.

AS 101 Zoology (1 1/2 Course Unit)

Introduction to living organisms; the major animal phyla with emphasis on the vertebrates, particularly mammals, including a comparative study on their anatomy, reproduction and development. The Protozoa and parasitic worms, emphasizing those responsible for diseases in domestic animals. A study of the arthropods emphasizing the economically important groups. Avian biology and histology including the development of the chick from egg to hatching. Fisheries and fish biology. Mammals with emphasis on rodents and hoofed mammals.

AS 102 Animal Physiology I (1/2 Course Unit)

A short treatise of physiology of farm animals with emphasis on regulatory systems involved in fluid, electrolyte and acid-base balance; metabolism, reproduction; integration and control of the body.

Animal Production

The work will include practical operations with the poultry flock, the piggery and the dairy herd. Emphasis will be given to the development of an appreciation for the day-to-day operations and the importance of these to overall management.

Farm Planning and Management (3 weeks)

Part of this period will be spent in the Kabanyolo area visiting small-scale farms to gain an appreciation of farm planning and management problems. The remainder will be spent in the student's own district conducting a farm management analysis which will form the basis of a farm management case study report.

Excursion to Selected Areas of Kenya (1 week)

A one-week excursion to selected areas of Kenya to visit centers of agricultural interest.

Practical Training in Forestry During Vacations (25 weeks)

Introduction to Forest Practice (1 week)

Introductory practice period in the first short vacation to enable the students to get acquainted with the forest milieu.

Forest Biology A (3 weeks)

Exercises in forest botany. Forest nursery practice. Site preparation for planting. Planting and weeding. Pruning.

Wildlife Ecology (1 week)

Identification of game and game sport in a forest area and estimation of numbers. Identification of damage due to game animals. Demonstration of game, excursion barriers and trapping methods. Silvicultural techniques for minimizing game damage of forest plantations.

Forest Engineering A (3 weeks)

Cutting in natural and planted stands. Skidding and hauling with tractors. Maintenance of tools, power saws and tractors. Loading of trucks.

Forest Mensuration A (3 weeks)

Use of instruments for determining different measures on individual trees. Measurements of stands. Computation of commonly used expressions of diameter, basal area, height, volume and increment. Stockmapping.

Surveying (2 weeks)

The use of important surveying instruments and elementary surveying exercises. Draughting and interpretation of maps.

Forest Biology B (1 week)

Control of weeds and weed trees. Tending of stands. Regeneration falling in plantations and natural forests.

Sawmilling (1 1/2 weeks)

Grading and measurement of timber and lumber. Sawing in a small mill. Production and work studies in a large mill.

Forest Mensuration B (1 week)

Surveying and measuring of a sizable forest area with subsequent calculations. Use of aerial photos.

Management and Administration (4 weeks)

Preparation of a management plan for a forest area or analysis and correction of an existing management plan. Establishment of a short term budget and plan of action for the same area including labor and equipment input plan, forest industries development plan, marketing plan, etc.

Field Trips (4 weeks)

(a) Shorter trips to areas of interest in the regions where the practical training is undertaken.

(b) One large field trip in the Eastern African region to study forestry and forest industries. Also other types of natural resource use, as wildlife and water resource management, will be covered.

CS 101 Botany (1 1/2 Course Units)

Anatomy: Cell structure and basic cell types; synthesis of these into a study of basic plant structures and changes related to aging.

Morphology: The gross structure of plants with special reference to the relationships between form and function. The concept of the plant as a unit and modifications met under conditions of environmental stress.

Taxonomy: A background survey of the plant kingdom and the importance of various groups. The Angiosperms (seed plants and the importance of this group within agriculture and forestry evolutionary trends within the group and families of forestry and agricultural importance. Reproductory mechanisms.

Mycology (agriculture students only): The classification, morphology, life cycles of eumycetina (true fungi) and their economic importance.

CS 102 Genetics (1/2 Course Unit)

Simple mendelian genetics, other forms of gene action; continuous and discontinuous variation; genotypes and phenotypes; genes, allelomorphs and loci; different types of inheritance of two pairs of alleles; measurement of linkage; gene frequency in populations; the genome concept; polyploidy; mitosis and meiosis.

CS 103 Plant Physiology (1 Course Unit)

The composition of the plant body. Uptake of water; inhibition, osmosis, suction pressure. Transpiration, re-regulation of water loss, transpirational pull. Mineral requirements of plants; mechanism of salt uptake, ion antagonism and synergism, the physiological effect of salt types. Photosynthesis; the experimental evidence for the physiology and chemistry of the process, factor affecting photosynthesis; subsequent metabolism of carbohydrates. Respiration; an outline of the chemistry of aerobic respiration, energy transfer mechanism, derivation of major plant body components. Nitrogen metabolism; nitrate reduction, amino acids, nucleic acids, protein formation. Physiology of growth and development; the fundamental growth process, growth substances (also their action in plant movements), factors affecting growth.

CS 104 Agronomy I - Principles of Agronomy (1 Course Unit)

Biological and types of economic yield, their interrelations; yield and radiant energy fixation. The crop as production unit; density-yield functions; radiant energy interception and utilization; crop growth rates and their parameters; crop development cycles and partition of assimilates. The influence of environment factors upon yield and its parameters; single factor-yield functions and their use in agriculture; factor interaction; factor regimes, their influence upon agronomic potential and their modification in field practice.

CS 105 Ecology and Climatology (1 Course Unit)

An introductory course on the concepts of ecology and their relevance to land utilization covering both botanical and zoological aspects. Includes an introduction to the basic concepts of habitat, ecosystem and of productivity. Locally important ecosystems such as swamps, lakes, game reserves, etc., are used to illustrate these concepts.

Introduction to meterology and climatology as related to East African agriculture and forestry. Atmosphere and earth energy budget. Global and regional climate and weather systems. Aerial and soil microclimate. Water budget in soils and crops. Instrumentation and observation techniques. Data collection, analysis and interpretation. Weather synoptics and forecasting. Climate modification and adaptation in agriculture and forestry.

FO 101 Forest Economics I (1 1/2 Course Units)

The course is sponsored jointly by the Departments of Forestry and Rural Economy and Extension. It includes part of RE 101.

Content: Forestry, agriculture and other forms of natural resources uses in the world and in East Africa. The importance of forestry in the life economy and development of East Africa. Forestry as a profession. The major steps in forest production and wood utilization. Productive and amenity functions of forestry.

National income accounting and planning. Stages of development, alternative development strategies. Supply demand and price formation with special reference to forest products. Introduction to the theory of the firm. Labor and industry in East Africa. "Money and banking."

FO 102 Forest Biology I (1 1/2 Course Unit)

Plant geography. Classification and identification of principal forest trees of East Africa and of interesting exotic trees to East Africa, their ecological requirement. Forest vegetation and classification. Forest ecology including forest micro-biology. Tree physiology.

FO 103 Forest Engineering I (1 Course Unit)

The course is sponsored jointly by the Department of Agricultural Engineering and the Department of Forestry. It includes first part of AE 101.

Content: Engineering materials. Fundamental mechanical elements and principles. Power unit principles and tractor types. Forest hand tools and power saws. Logging ropes with attachments. Introduction to logging machinery.

FO 104 Mathematical Statistics (1 1/2 Course Units)

The course is sponsored jointly by the Departments of Forestry and Rural Economy and Extension. It includes part of RE 102. The practicals are related to FO 202.

Content: Frequency distribution. Measures of central tendency and of dispersion. Sampling theory. Analysis of time series. Analysis of variance. Correlation and regression. Curve fitting and transformation of coordinates. Numerical methods.

FO 105 Wood Utilization I (1 Course Unit)

Structure of the cells, tissues and organs of woody plants. Macroscopic and microscopic identification of wood species important in East Africa. Structural features of cell walls.

RE 101 Introduction to Agricultural Economics (1 1/2 Course Units)

This course is offered jointly by the Departments of Forestry and Rural Economy and Extension.

Principles of resource allocation, income, output and price determination; introduction to theory of the firm, money and aggregated demand, international trade and agricultural development.

RE 102 Introduction to Statistics (1/2 Course Unit)

Basic concepts of statistics. Frequency distributions, presentation of raw data, measures of central tendency, measures of dispersion, elementary sampling theories, and time series analysis.

## Year II

AC 201 Soil Science II (1 Course Unit)

Basic soil physics, including texture, structure, porosity, water and energy relationships. Clay mineralogy. Basic principles of soil chemistry including soil colloids, ion exchange, and soil reaction. Sources of availability of nutrients in soils.

AC 202 Soil Science III (1 Course Unit)

Soil-plant relationships and soil fertility in East Africa. Fertilizer materials and soil amendments. Responses of crops to different fertilizers. The microbial population of the soil. Microbial transformations of nutrient elements in the soil. Soil organic matter.

AE 201* Soil/Water Conservation Engineering (1 Course Unit)

Principles and techniques of soil and water conservation. Hydrology, drainage and irrigation. Rural water supplies and pumps. Farm planning and design.

AE 202 Farm Mechanization (1 Course Unit)

Application of agricultural power units: oxen, small tractors, and large tractors. Field machinery: ploughs, machinery for seedbed preparation, seeders and planters, fertilizer distributors. Spraying and dusting. Crop harvesting, processing and preservation.

AS 201 Animal Nutrition I (1 Course Unit)

Principles of nutrition. Proximate composition of feeds. The biochemistry and physiology of digestion, absorption, transport and metabolism of nutrients. Differences in species are discussed. Comparative nutritive requirements for various body functions: maintenance, growth, reproduction and lactation. Feeding standards: their application to various forms of livestock.

AS 202 Livestock Production (1 Course Unit)

Consideration of factors influencing animal production with reference to the tropics. Management of beef cattle, sheep, goats, and swine. Management and other factors influencing the value of hides and skins.

AS 203 Poultry Management (1/2 Course Unit)

Principles of management and production of poultry and poultry products in East Africa. Hatching, growing and maintenance of meat and egg producing flocks in the various species of poultry. The effects of environment on systems of poultry production.

CS 201 Agronomy II (Annual Crops) (1 Course Unit)

Types of annual crops and their importance in East Africa; distribution of annual crops in relation to East African environments; application of agronomic principles in the production of grain, pulse, oil seed, root and industrial crops within the East African environments. Annual crop enterprise economics.

CS 202 Principles of Crop Protection (1 1/2 Course Unit)

Biological and economic damage caused by weeds, pathogens and pests. Crop protection and world crop production; the ecology of cultivated plants in relation to crop protection, principles of control. Brief survey of organisms which cause disease in plants. Some major diseases, weeds, pests of East African crops and their control. Principles of field use of chemicals for crop protection.

CS 203 Applied Statistics (1 Course Unit)

Use of statistics in agricultural experimentation; normal distribution and its parameters; standard error of a difference; use of the "t" test. Calculation of linear regressions and correlation coefficients data transformation. Analysis of variance for randomized block, latin squares, simple factorials and split plots. Field techniques and factors determining the choice of experimental design.

FO 201 Forest Biology II (2 Course Units)

The silvics of indigenous and imported tree species silvicultural techniques. Silvicultural systems. Natural regeneration. Tree improvement and selection of provenances. Procurement of seed. Forest nurseries. Forest plantations. Pruning and thinning. Choice of regeneration method.

FO 202 Forest Mensuration (1 1/2 Course Units)

Properties of measurements. Equipment. Measuring individual trees, stands and whole forests. Surveying; surveying instruments. Introduction to aerial survey and photo interpretation. Forest mapping.

FO 203 Management Planning (1 Course Unit)

Basic principles and techniques applied in the preparation of management plans such as long-term yield regulation, short-term planning or removal, and of labor and capital input. Application of operation research methods in forest management.

FO 204 Forest Engineering II (2 Course Units)

Trafficability and mobility. Terrain transport machinery and methods. Winch and rope-way transport. Air transport. Terminal equipment and operations. Maintenance of machines and equipment. Work studies. Work physiology and psychology. Types and specifications of forest roads. Road construction machinery and equipment. Planning, set-out, construction and maintenance of forest roads. Culverts and bridges. Construction contracts. Planning and control of logging operations.

FO 205* Forest Economics II (2 Course Units)

This course is sponsored jointly by the Departments of Forestry and Rural Economy and Extension.

Content:

a. General principles; goal formulation. Decision theory. Cost and revenue analysis. Theory of the firm. Time, risk and uncertainty in decision making. Credit. Taxation.

b. Application of the principles in the management of forestry and other natural resources, for example, plantation investments, determination of optimal rotation, comparative evaluation of different resource use.

c. Marketing with special reference to forest products.

FO 206 Wood Utilization II (2 Course Units)

Sawmill location and design. Sawing patterns and techniques for different types of wood sawmill productivity and efficiency. Different uses of sawn wood. Physical and mechanical properties of wood. Seasoning and preservation of wood. Grading and measurement of timber and lumber. Wood as fuel. Charcoal. Minor forest products. Identification of different types of wood defects and their causes.

### FO 207 Wildlife Ecology (1 Course Unit)

General ecology of mammals, birds, reptiles and fish. The processes of population growth, dispersion and natural control of the most important animals in East Africa. The interaction between these animals and their environment. Game animals as a land and forest resource. Management and harvesting of game.

### RE 201 Production Economics and Farm Management (2 Course Units)

(a) Production Economics: Rational decision making in communal and individual forms of agricultural organization. Time, uncertainty and risk in agricultural production. Economic principles of land tenure, credit, conservation, mechanization, etc., at the individual farm level. Investment analysis.

(b) Farm Management Economics: Management accounts and farm planning; gross margin; partial and whole farm budgeting; program planning and linear programming. Credit appraisal.

(c) Enterprise Economics: The application of production economics and farm management principles to various farm enterprises in both the crop and livestock production processes.

### RE 202 Agricultural Extension and Rural Sociology (1 1/2 Course Units)

(a) Agricultural Extension: The principles of extension. Program planning. Extension methods. Preparation of visual aids. Evaluation.

(b) Rural Sociology: Sociological analysis of traditional society and social change. Social factors affecting nutritional welfare development planning and specific measures of induced change.

## YEAR III

### AE 301 Farm Structures and Farmstead Mechanization (1/2 Course Unit)

Principles of farm structures. Rural mechanical aids. Mechanization of crop production barn machinery; livestock buildings and machinery.

AS 302 Animal Breeding (1 Course Unit)

The role of genetics and breeding in the improvement of East African livestock; heredity and environment; systems of selection; standards of selection; standards of evaluation for evaluation for livestock improvement; population genetics.

AS 303 Animal Physiology II (1 Course Unit)

A practical treatment of adaptive mechanisms of animals to environment, physiological functions of growth, lactation and reproduction; detailed consideration of reproductive efficiency and artificial insemination.

AS 304 Dairy Management (1/2 Course Unit)

Factors which affect the successful management of a dairy herd. The growth and development of animals, economic factors, milk secretion, advanced problems in management under East African conditions.

AS 305 Processing of Agricultural Products (1 Course Unit)

The purpose and value of processing. Physical, biochemical, and microbiological aspects of the extraction, conversion and preservation of agricultural raw materials.

AS 306 Human Nutrition (1/2 Course Unit)

Basic principles of human nutrition with emphasis on nutritional problems in rural areas and the effective utilization of available foods.

AS 307 Animal Health and Hygiene (1 Course Unit)

Health and disease as it affects farm animals. Animal parasitology. Management problems for disease control.

AS 308 Special Topics in Animal Production (1/2 Course Unit)

Presentation and discussion by students in seminars of assigned topics in Animal Production.

CS 301 Agronomy III (Horticulture) (1 1/2 Course Unit)

The importance of vegetables, fruits, and ornamentals in developing countries with particular reference to East Africa. Methods of propagation, use of fertilizers, irrigation and other cultural practices including the use of plant growing structures.

CS 302 Agronomy IV (Perennial Crops) (1/2 Course Unit)

Types of perennial crops and their economic importance in East Africa. Distribution of perennial crops in relation to East African environments. Application of agronomic principels to the production of coffee, sisal, tea, pyrethrum, cloves, sugar cane, pineapples, coconuts, cocoa, citrus and other fruit crops within East African environments. Propagation, pruning and grafting techniques as applied to these crops.

CS 303 Agronomy V (Pasture Agronomy) (1/2 Course Unit)

Grassland ecology; range types and their value; the characteristics of East African grass and legume species principles of grassland production; range and grassland management and improvement; sown grassland, their establishment, management and utilization; conservation of grassland production; measurements of grassland productivity and the animal-grassland complex.

CS 304 Economic Botany and Crop Physiology (1 Course Unit)

Domestication of plants for food, fibers, oils, building materials, drugs, spices, etc.; major botanical orders of economic significance; polyploidy and crops, the geneme concept; crop classification at sub-specific level; crop morphology and economic adaptation. Crop water relations; root development, loss of water from green vegetation, water 1 loss under "oasis conditions". Mineral nutrition of plants; deficiency symptoms, foliar absorption of minerals, plant analysis. Factors affecting dry matter production of a crop; light utilization. Carbon dioxide; fluxes in plant stands, "soil respiration", plant responses to above normal concentrations. Growth analysis. Plant growth substances in relation to uses in agriculture. Day length and temperature effects on growth and reproduction. Physiology of seeds in relation to storage, viability and germination. Post-harvest physiology of fruits in relation to storage conditions and storage life, distribution and marketing conditions.

CS 305 Plant Pathology (1 Course Unit)

Types of plant disease symptoms. The control of plant diseases by chemical and cultural methods, and through quarantines and the breeding of resistant varieties. Some important diseases of East African crops and their control. Elementary concepts of host-parasite relations and of epidomielogy.

CS 306 Plant Pests (1 Course Unit)

Plant pest ecology. Pest damage and pest outbreaks, forecasting pest attacks. Methods and principles of pest control: legal, cultural, physical and mechanical control; biological, chemical and integrated control. The major pests of East African crops.

CS 307 Crop Improvement (1 Course Unit)

Natural breeding systems in plants; genetic nature of wild and cultivated populations; phenotypic and gerotypic variation; selection criteria in different crops; breeding systems used in annual and perennial crop plant improvement; gene pools, composite populations; breeding for disease resistance, test resistance and positive physiological characteristics. Testing of new material.

FO 301 Forest Protection (1 1/2 Course Unit)

Characteristics, life histories, forest relationships and control of economically important forest insects. Prevention and control of damage of forest trees by disease. Survey of the important forest tree diseases and their relation to forest management and forest utilization. Fire behavior and effects. Prevention, detection and control. Danger measurements. Use of fire in wildland management.

FO 302 Wood Utilization III (1 Course Unit)

Pulp and paper production. Veneer and plywood manufacture. Production of fiber boards and particle boards. Other wood-based products. Properties and uses of different forest products. Timber engineering and design.

FO 303 Forest Management and Administration (2 Course Units)

Accounting theory. Accounting in private and public firms. Preparation of budgets. Economic evaluation and control of accounts, budgets and management plans. Organization theory. Personnel administration. Administration procedures in private and public firms.

FO 304 Forest Engineering III (1 Course Unit)

Truck road transport equipment and methods. Railway transport. Water transport. Pipeline transport. Interaction between transport means and transport lines. Handling and storage of forest raw materials. Competition and interaction between different transport methods. Planning and control of transport operations. Fire fighting equipment and methods.

FO 305* Land Use Law and Policy (1 1/2 Course Unit)

The course is sponsored jointly by the Department of Forestry and Department of Rural Economy and Extension. Elements of laws of land and property. Laws regulating water use and forest reservation protection and production. The principles of extension and extension methods. The influence of land use on capital and labor requirements. Land use policies as part of the national policies of East African countries. Goals and measures in land use policy.

RE 301 Agricultural Development (1 Course Unit)

Alternatives development strategies; the role of the Agricultural Sector in Economic Development and dynamics of economic and social change. Development planning and project evaluation; the economic analysis of direct and indirect investment of public funds in the agricultural sector with particular reference to Uganda (and East Africa in general).

RE 302 Agricultural Marketing (1 Course Unit)

The economic analysis of agricultural price, marketing and taxation policies with particular reference to Uganda (and East Africa generally). Functional, commodity and institutional aspects of marketing of selected major commodities. International Trade and Commodity Markets.

RE 303 Agricultural Administration and Plan Implementation (1 Course Unit)

Administrative, social and economic aspects of agricultural development administration, agricultural administration organization, public administration and personnel management; plan implementation of programs and projects and plan evaluation.

RE 304 Agricultural Cooperatives and Credit (1 Course Unit for Education and Management option and 1/2 Course Unit for Animal and Crop option)

Organization, functions and contribution of cooperatives in the economic system; credit savings and investment in a peasant society and the role of credit and credit institutions in agricultural development in East Africa.

RE 305 Special Topics in Rural Development (1/2 Course Unit)

Special seminar course for Management Option to provide student opportunities to present papers on various topics in agricultural economics. The course will also include attendance at Rural Development Research seminars.

*Practical Training in Agriculture During the Vacations (Pre-entry Practical Training) (4 weeks)

Students will spend four weeks on selected small-scale farms normally in their own districts to gain an appreciation of the problems and practical skills involved in peasant scale agriculture.

*Practical Training on Large Scale Agricultural Enterprises (3 weeks)

Students will spend three weeks on selected large agricultural estates, institutes or farms to gain an appreciation of practical and labor management problems associated with such enterprises.

Training in Practical Skills (6 weeks)

Students will spend six weeks at the University Farm, Kabanyolo on the training program described below:

(a) Agricultural Engineering: Techniques of land preparation and achieving optimum time of planting; plant population, distribution and crop protection; mixed farming and barn machinery.

Techniques of surveying with chain and compass, plane table, simple level and theodolite; simple cartography map and airphoto interpretation.

(b) Crop Production: Seedbed preparation and sowing. Methods of vegetative propagation. Fertilizer use and application. Plant protection, use of sprays, etc. Harvesting of crops. Experimental techniques, laying out of plots, observations within plots, yield measurement and components of yields.

*(c) Agricultural Extension: Preparation of demonstration materials; organization and presentation of Method Demonstrations.

*Subject to funds being made available.

It can be seen from the comparison of the 1968 and 1971 syllabi that there was considerable change in the numbering of courses, their titles and course description (see 1971 course numbers, titles and description in the preceeding pages and those for 1968 in Appendix M). There was also some reallocation of time between departments and changes in the time during the students' program when certain courses are offered. The most significant changes were in placing all biochemistry in Year I and all soil chemistry in Years I and II

Courses in Rural Economy were changed in title course unit weighting and proposed content. The courses in Introductory Statistics Cooperatives and Credit; and Special Topic (seminars) were new additions (see Appendix N for the Rural Economy syllabus changes). Another large number of courses which were added to the 1971 syllabus were the Forestry courses. Many were offered in part or fully in cooperation with agriculture courses but all had FO prefixes and numbers.

The electives which were inaugurated in 1968 were eliminated in 1971. The Committee and Faculty Board felt there were too few electives offered to provide much impact in the course of study and it would be better to wait until the Faculty moves to a four-year curriculum.

In addition to completing the above syllabus, students are required to fulfill the following requirements for B.Sc. (Agriculture):

(a) Conduct and write up a special project during the long vacation between the second and third year.

(b) Submit a Farm Management Case Study by the end of the second year (this is a new addition to the syllabus).

(c) Satisfactorily complete the following vacation practical training program:

| | Weeks |
|---|---|
| Practical training on small scale farm | 4 |
| Practical training at large scale agricultural centers | 3 |
| Training in practical skills at Kabanyolo | 6 |
| Farm planning and management excursions | |
| Uganda | 1 |
| Kenya | 1 |
| Total | 15 |

*These programs are subject to funds being made available.

Students reading for the B.Sc. (Forestry) will be required to:

(a) Conduct and write up a special project; the topic of which will be selected in consultation with Department Head prior to Term III, Year II. The project is intended to train students in independent planning, execution and evaluation of assignments.

(b) Submit a forest management analysis. On the basis of data collected during field training, each forestry student will conduct and write up a plan for a forest district or analyze an existing forest management plan. He will also develop a short-term budget and plan of action for the same area, including labor and equipment imputs required, a forest industry plan, marketing, etc.

(c) Complete the following practical training:

| | Weeks |
|---|---|
| Introduction to Forestry Practice | 1 |
| Forestry Biology A | 3 |
| Wildlife Ecology | 1 |
| Forest Engineering A | 3 |
| Forest Mensuration A | 2 |
| Surveying | 2 |
| Forest Biology B | 1 |
| Forest Engineering B | 1 1/2 |
| Sawmilling | 1 1/2 |
| Forest Mensuration B | 1 |
| Forest Management and Administration | 4 |
| Field Trips | 4 |
| Total | 25 |

(d) Students are encouraged to take vacation employment prior to entry and during vacation periods. The duration of this training required is 10-15 weeks.

In order to make a smooth transition to the new syllabus changes there were some variations in the course offerings during the 1971-72 academic year. This was done to accommodate the subjects previously taught in the Second Year which were transferred to the First Year of the B.Sc. (Agriculture). The complete revised 1971 syllabus will be put into full effect in the 1972-73 academic year. See the interim modifications used in the transition year below.

| | | Proposed<br>Course Units | To be taught in 1970-71<br>Course Units |
|---|---|---|---|
| AC 201 | Soil Science II | 1 | 1 |
| AC 202 | Soil Science III | 1 | 1 |
| AE 201 | Soil/Water Engineering | 1 | 1 |
| AE 202 | Farm Mechanization | 1 | 1 |
| AS 201 | Animal Nutrition I | 1 | 1 |
| AS 202 | Livestock Management | 1 | 1 |
| AS 203 | Poultry Management | 1/2 | 1/2 |
| CS 201 | Annual Crops | 1 | 1 |
| CS 202 | Crop Protection | 1 1/2 | 1 |
| CS 203 | Statistics | 1 | |
| RE 201 | Production Economics | 2 | 1 1/2 |
| RE 202 | Extension and Sociology | 1 1/2 | 1 1/2 |
| AC 105 | Soil Science I | -(1) | 1/2 |
| AC 102 | Biochemistry II | -(1 1/2) | 1 |
| AS 102 | Animal Physiology I | -(1/2) | 1/2 |
| | Total | 13 1/2 | 14 |

Revised Examination Scheme

The two significant changes in the Faculty which occurred during the period of this contract relative to undergraduate teaching were the development of the course unit system and the new examination scheme. Under the old examination system students were given seven 3-hour and two 2-hour practical examinations at the end of the first year, seven 3-hour examinations after the second year and five 3-hour examinations at the termination of the third year.

In 1968 the revised syllabus provided for final examinations to be held at the end of the second and third years. Continuous assessment counted up to one-third of the marks awarded for any course and the lecturers did their own continuous assessment and assigned marks. All first-year courses were examined by the lecturer of that course.

The 1971 revised syllabus provided for course unit examination to be held throughout the entire 3-year degree program. Final comprehensive examinations will be held at the end of the second and third years. Continuous assessment, including course unit examinations plus final examinations, will decide whether a degree is awarded and the classification of the degree. There are some other features of the grading system and types of examinations which are included in the 1971 syllabus. The main features are the increase from 33 to 50 percent of the course mark will depend on continuous assessment.

Candidates for the B. Sc. in Agriculture will be required to take four final comprehensive examinations at the end of the second year and three at the end of the third year. The total number of final examinations will be reduced from eleven to seven. Greater attention will be paid to framing examination papers within boundaries of related broad subject matter areas.

The Grade Point Average will be used in determining whether a student remains in the Faculty. A minimum GPA of 2 is the lower limit used to decide whether a student is awarded a degree. The 1971 revised examination scheme is presented below.

A. Course Unit Examinations

(1) All course unit examinations will be internal Faculty examinations. The questions will be set and graded by the lecturers responsible for the course and the grades obtained approved by a Faculty Examination Committee before publication. The nature of course unit examination questions will be both objective and integrative, but the examination will progressively change from a more objective examination of factual material in the first year to a more integrative type of examination in the final year.

(2) Course unit examinations will, as far as possible, examine the whole range of material covered in a particular course.

(3) Up to one-half of the marks awarded for any course unit examination may be based on continuous assessment.

(4) Course unit examinations will be held as soon as possible after the course has been completed.

(5) Normally course unit examinations will be based on the formula of not more than one hour duration for each 1/2 unit, although additional time will be permitted in cases where a practical exercise makes up part of the examination.

(6) Course unit examinations will be awarded a grade only, which need not necessarily be related to precentage marks, but to performance in and standard of the examinations.

(7) The grading system will be as follows:

| | |
|---|---|
| Excellent | 5 |
| Good | 4 |
| Satisfactory | 3 |
| Fair | 2 |
| Compensatable failure | 1 |
| Clear failure | 0 |

(8) A student must obtain an accumulative grade point average (GPA) or two or more before being permitted to proceed from one year to another or to be awarded a degree. The GPA will be calculated by multiplying the course grade by the course weighting, adding the products and dividing by the total number of courses.

(9) A student who maintains an accumulative GPA of two or more at the end of each successive year will normally be required to resit all failed courses and obtain a grade of 1 or more in the resit examination. A student will, however, be permitted a total of not more than 2 zero grades at the end of the third year.

(10) Referred examinations will be held at the beginning of the first term of the following year.

## B. Final Examinations for the B.Sc. Agriculture and B.Sc. Forestry

(1) As a student's detailed knowledge of agriculture and forestry will have been examined in course unit examinations, final papers will contain a relatively wide choice of questions of an integrative nature to give students the opportunity to write on those topics in which they have developed a particular interest.

(2) Final examinations will be made up of a Part I Examination taken at the end of the third year.

(3) To pass the Part I Examination a student must:

a. Average a pass in the three papers making up that examination

b. Pass at least two of the three papers making up that examination

(4) To pass the Part II Examination a student must:

a. Average a pass in the four papers making up that examination

b. Pass at least three of the four papers making up that examination

(5) A student who averages a pass in the Part I or Part II examination but who has failed more than one paper will be referred in the failed papers. If after taking the referred papers he meets the conditions in (3) or (4) above, he will be permitted to proceed to the third year or be eligible for the award of the appropriate degree. If the student does not meet these conditions, he will normally be asked to repeat the year.

C. Structure of Final Part I and Part II Examinations

(1) The Part I Examination for the Bachelor of Science in Agriculture will be made up of three 3-hour final papers as follows:

  a. Paper I--Mechanization; soil formation, classification and conservation; soil/water engineering; farm planning and management.

  b. Paper II--Principles of soil chemistry, physics and fertility; principles of agronomy, ecology and crop protection.

  c. Paper III--Principles of animal nutrition; livestock and poultry management.

(2) The Part I Examination for the Bachelor of Science in Forestry will be made up of three 3-hour final papers as follows:

  a. Paper I--Forest botany, tree physiology, silviculture, forest and wildlife ecology, soil and water relations.

  b. Paper II--Fundamentals of engineering, felling and transport tools and machinery, roads, hydrology, work studies.

  c. Paper III--Forest mensuration and statistics. Economics of forestry and other natural resources, forest valuation.

(3) The Part II Examination for the Bachelor of Science in Agriculture will be made up of our 3-hour final papers as follows:

  a. Paper I--Agronomy including annual crops, perennial crops, pastures and horticulture

  b. Paper II--Dairy management, animal feeding, processing and marketing of agricultural products.

  c. Paper III--Production economics, enterprise economics, agricultural extension, rural sociology, farm structures and mechanization.

  d. Paper IV--Crop option: Crop pests and diseases, crop physiology, crop improvement.

e. Paper IV--Animal Option: Animal breeding, reproductive physiology, animal health and hygiene.

f. Paper IV--Management and Extension Option: Agricultural development, administration and plan implementation; cooperatives and credit schemes.

g. Paper IV--Education Option: Agricultural development; cooperatives and credit schemes, farmer and farm youth organizations, school farm management.

(4) The Part II Examination for the Bachelor of Science in Forestry will be made up of four 3-hour final papers as follows:

a. Paper I--Wood utilization: Wood properties and uses, wood-based industries.

b. Paper II--Forest management: Management of forest for wood and water production. Erosion control. Multiple use of forest land, forest protection.

c. Paper III--Forest management: Management of felling, extraction and delivery of forest products. Planning, construction and maintenance of transport systems.

d. Paper IV--Forest management: Principles of forest management and administration. Land use law and policy forest extension.

(5) In addition to the above final papers, students will be expected to submit the following:

a. A special project report during the third year.

b. A farm management case study before the end of the year (Agriculture students only).

c. A forest management analysis during the third year (Forestry students only).

(6) All final papers and the special project reports will be examined by both internal and external examiners. The final results recommended to Senate for approval should be agreed to by both Internal and External Examiners, although in cases of disagreement the recommendation of the External Examiner will normally prevail.

(7) Results of the Part I and Part II examinations will require the approval of Senate or the Vice-Chancellor on behalf of Senate before publication.

## D. Classification of the Degree

(1) For the purposes of degree classification, equal weighting will be given to the two components below:

a. Course unit examination grades

b. Final papers, special project report and farm management case study or forest management analysis.

(2) For the purpose of degree classification the original grade or mark obtained in the case of referred examinations will be used.

(3) To enable the incorporation of course unit examination grades into degree classification, the accumulative GPA for the three years of the degree program will be converted to a percentage mark according to the table below:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.00 | 45% | 3.00 | 55% | 4.00 | 65% | 5.00 | 75% |
| 2.1 | 46% | 3.1 | 56% | 4.1 | 66% | | |
| 2.2 | 47% | 3.2 | 57% | 4.2 | 67% | | |
| 2.3 | 48% | 3.3 | 58% | 4.3 | 68% | | |
| 2.4 | 49% | 3.4 | 59% | 4.4 | 69% | | |
| 2.5 | 50% | 3.5 | 60% | 4.5 | 70% | | |
| 2.6 | 51% | 3.6 | 61% | 4.6 | 71% | | |
| 2.7 | 52% | 3.7 | 62% | 4.7 | 72% | | |
| 2.8 | 53% | 3.8 | 63% | 4.8 | 73% | | |
| 2.9 | 54% | 3.9 | 64% | 4.9 | 74% | | |

(4) To enable the incorporation of final paper marks, special project report and the farm management case study or forest management analysis these will be converted to an average percentage mark as below:

| | B.Sc. Agriculture | B.Sc. Forestry |
|---|---|---|
| 7 final papers | 700 | 700 |
| Special project report | 100 | 100 |
| Farm management case study or forest management analysis | 50 | 100 |
| | 850 | 900 |

The marks received from the total possible mark will be divided by 8.5 for the B.Sc. (Agriculture) and 9 for the B.Sc. (Forestry) to convert to an average percentage mark.

(5) Degree classification will be worked out as below:

$$\frac{\text{Average \% Course Units + Average \% Final Papers, Special Project and Management Report/Analysis}}{2}$$

The % mark obtained will be used to classify the degree as below:

| | |
|---|---|
| 40 - 49.9 | Pass |
| 50 - 59.9 | Lower second class honors |
| 60 - 69.9 | Upper second class honors |
| Above 70 | First class honors |

The Faculty Board may, under special circumstances, recommend that a student obtaining marks of 45-49.9%, 55-59.9% or 65-69.9% be awarded a lower second, upper second or first class honors degree, respectively.

E. Bars

(1) To proceed from the first to the second year a student must obtain an accumulative GPA of 2 or more for course unit examinations.

(2) To proceed from the second to the third year a student must:

a. Have an accumulative GPA of 2 or more for course unit examinations.

b. Have an average mark of 40% or more in the Part I examination.

c. Have submitted a farm management case study (Agriculture students only).

(3) To be awarded a degree a student must:

a. Have an accumulative GPA of 2 or more for course unit examinations.

b. Have an average mark of 40% or more in the Part II examination.

c. Have submitted a special project report.

d. Have submitted a forest management analysis (Forestry students only).

e. Have a rating of satisfactory or better in practical training.

f. Have made up all course unit examinations in which a grade of zero was obtained although a student will be permitted a maximum of 2 zero course unit grades at the end of the third year and be eligible to be awarded a degree.

g. Have made up all final papers failed in excess of the one failure permitted in each of the Part I and Part II examinations.

A student who does not meet these requirements will normally be discontinued. The recommendation of the Faculty Board will, however, be based on a study of each individual case.

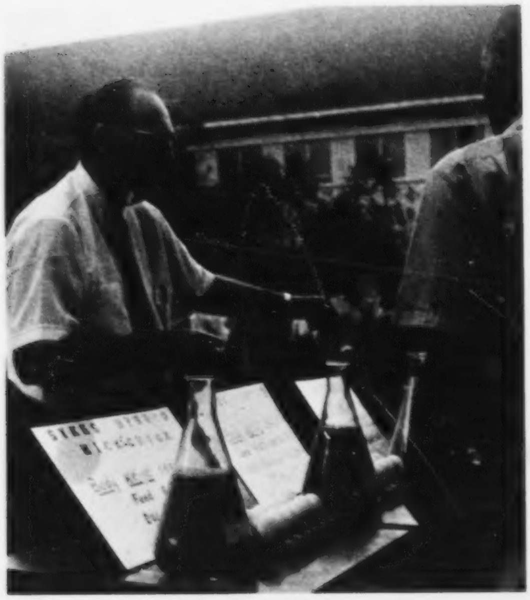
## Special Projects

Students studying for the B.Sc. in agriculture are required to complete a special project during the long vacation following the second year. This project is a research project which emphasized original inquiry by the student in his chosen area of interest. The projects must be written in the form of a research report and the stipulated length is 10,000 words. During recent years, more emphasis has been given by staff members to content of material, analytical procedure and style of writing. This has been accomplished by providing special lectures to students before they do their research and after they return just before they do their final write up.

Each student has two staff member supervisors who provide guidance. All project reports are examined and graded by Faculty members and the External Examiner. The participation of contract staff members, over the years, is presented in Table 7.

Table 7. Special Projects Supervised by West Virginia Contract Staff, 1967-1971

| Staff Member | 1967-68 | 1968-69 | 1969-70 | 1970-71 | 1971-72 |
|---|---|---|---|---|---|
| O. J. Abbott | -- | 2 | 2 | 1 | 4 |
| V. F. Amann | -- | -- | 12 | 4 | 5 |
| Philip Kelly | 4 | 9 | -- | -- | -- |
| D. L. McIlroy | -- | -- | 3 | 2 | 4 |
| P. G. Moe | -- | -- | 3 | 4 | 3 |
| Ralph Nelson | -- | -- | 6 | -- | -- |
| Farrel Olsen | 2 | 2 | 1 | 7 | 2 |
| Richard Wurster | 3 | 2 | 3 | 4 | 1 |
| W. A. van Eck | 5 | 1 | 6 | 6 | 1 |
| Totals | 14 | 16 | 36 | 28 | 21 |
| Number students with Special Projects | 36 | 47 | 78 | 79 | 72 |



TOP: Left and Right, Dr. O. J. Abbott is shown with his Kabanyolo Open Day displays which center around his research on comparisons of strains of chickens for production and marketability of eggs in Uganda.

RIGHT: Center and Bottom, Dr. Abbott and students make observations on poultry and swine.

The West Virginia University staff always carried a fairly heavy load in supervising undergraduates' special projects. With the growth in total staff relative to students, the number of projects supervised per staff member has decreased in most cases as has the total for the contract staff.

## Postgraduate Programs

At the time the contract was activated, Makerere did have a program leading to the awarding of a Postgraduate Degree. No candidates had, however, presented themselves for examination for the degree. It was primarily a dissertation degree. A prospective candidate presented a proposal for a research project, and if it were found acceptable by the Faculty Board of Postgraduate Studies, he was permitted to register for the degree. A supervisor was appointed by the Faculty and the student worked on the research program until he and his supervisor felt that the results would be accepted by an examination committee. He then presented his dissertation for review and approval and took oral and/or written examinations. If found acceptable by the examining committee he was recommended to receive the degree.

The McFarland-Turner report recommended the initiation of an in-residence program leading to a postgraduate degree. They suggested that additional formal course work beyond the Bachelor's level and working on campus under the close supervision of an advisor would lead to the development of future teachers and researchers highly capable of filling positions in research institutions and University facilities in East Africa.

A major objective of the contract was to assist the Faculty of Agriculture in developing an in-residence program of postgraduate instruction for 50-60 students in three postgraduate study and research programs.

### Development of Syllabus and Regulations

The first revision of the program of postgraduate instruction was accepted by the Faculty in 1966. It included:

1. One year of course work at the postgraduate level plus a short dissertation leading to the Diploma in Tropical Agriculture.

2. A two-year program with course work in common with the Diploma in Tropical Agriculture in the first year leading to the Master of Science Degree.

3. Research only for an indeterminate term leading to either the Masters or Doctors degree.

No students registered for the Diploma in Tropical Agriculture and it was discontinued.

Much discussion proceeded the development of a syllabus for postgraduate training. The emphasis of this syllabus was placed at the M.Sc. level. Course units were established and the Faculty Board approved the M.Sc. (Agriculture) program at a special meeting on August 15, 1969. The main features of the new M.Sc. training program are:

1. In the future, there will be two types of M.Sc. (Agriculture) degrees: one with a large component of course work supplemented with a research project, the other with a small component of course work plus a major research project. Both degrees will have the same minimum of 18 months duration for full-time students. Part-time students will require a longer minimum period and will spend an appropriate period at Makerere to take the course work.

2. The M.S. (Agriculture) mainly by course work will be particularly suitable for individuals intending careers in agricultural college teaching, agricultural administration, advanced extension work, and industries ancilliary to agriculture. Graduates with suitable attainment from tropical or non-tropical agricultural faculties as well as students from non-agricultural faculties will be eligible for the degree.

3. The M.Sc. (Agriculture) mainly by research is intended for graduates wishing to take up a career in agricultural research as their long-term objective. It will also be open to suitably qualified graduates from agricultural or non-agricultural faculties in tropical or non-tropical countries.

4. The M.Sc. (Agriculture) mainly by course work will contain a minimum of eight course units chosen from the two course unit types described below. The M.Sc. (Agriculture) mainly by research will contain a minimum of three such course units. In each case, at least one of these units will be chosen from the 'general' group.

   In addition, candidates may be required to take the 'Agricultural Development Strategy' course unit in which case the minimum course units in the M.Sc. (Agriculture) mainly by research will be raised to four. Course units from other faculties may be included in the choice for either type of degree

5. The course units in either degree may be spread over two academic year or, where necessary, may be concentrated into the first year. The major or minor types of research projects may be similarly spread over two academic years according to the dictates of seasonal or other factors.

6. The course work offered within each degree will be of two types:

   a. Formal courses, involving lectures, seminars, laboratory and/or practical field work, together with set reading

   b. Programmed self-study course, involving sequential reading lists, where the student will meet the lecturer at intervals for discussion and/or paper reading seminars; laboratory and/or field practical work may also be required.

   The courses will be numbered within a 400 series in which each 'formal' course has a proframed self-study course as an alternative under the same course unit number. The non-alternative type (b) units will also be in the 400 series.

7. Course units of each of the two types will contain 35 lecture equivalents.

8. Individual departments may require students to take one or more undergraduate course units in order to assist the graduate.

9. Guidance as to choice of course units will be a required duty of the student's supervisor; the final choice will be subject to approval of the Postgraduate Studies Board.

10. Final assessment of the candidate will be made by both Internal and External Examiners and will be based on:

    a. An assessment of the dissertation

    b. An assessment of written examinations, orals, or seminars related either to individual course units or a combination of course units as the Academic Board may recommend and Senate approve.

The pass mark for final assessment of course units or combinations of course units shall be 50 percent. All examination papers together with the dissertation shall be submitted to the external examiner for his consideration.

## Instruction and Supervision

The first postgraduate degree was awarded by the Faculty of Agriculture in 1967. By June, 1971, there were 12 Ph.D. candidates and 41 M.Sc. candidates registered in Agricultural Engineering and one in Forestry.

There had been a large increase in the number of Ugandans registered for higher degrees. In June, 1971, five out of 12 Ph.D. candidates and 23 out of 41 M.Sc. candidates were Ugandans. Other East African countries also had candidates in postgraduate training at Makerere. There were nine candidates from Kenya, two of which were registered for Ph.D., and one from Rhodesia.

Contracting staff members were supervisors and examiners for degree candidates. Table 8 shows the involvement of West Virginia University staff members in postgraduate supervising and examining.

Dr. P. G. Moe is also supervising students who are working on degrees in other institutions as listed below.

1. Mr. S. O. Keya (Ph.D.) - Nutritional factors limiting symbiotic nitrogen fixation of cowpeas and its homologous rhizobia in a tropical Uganda soil. (Registered at Cornell University, U.S.A.).

2. Mr. J. Y. Zake (Ph.D.) - Factors affecting the availability of sulfur in tropical soils. (Registered at Ohio State University, U.S.A.)

3. Mr. J. D. Pidgeon (Ph.D.) - The mapping of soil series within a catena. (University of Reading, U.K.)

Mr. V. F. Amann is supervising a Ph.D. student from Stuttgart, Germany, associated with the Makerere Institute of Social Research.

Mr. H. Jahnke - Economic survey and analysis of tick control in Uganda.

Table 8. Showing Contract Staff Member Involvement as Supervisors and Examiners of Postgraduate Students, June, 1971.

| Staff Member | Student | Degree | Supervisor | Examiner | Research Project |
|---|---|---|---|---|---|
| V. F. Amann | M. Hall | Ph.D. | | x | A farm management survey of the coffee banana zone on Buganda/Busoga |
| V. F. Amann | E. S. Katarkawe | M.Sc. | x | x | The resettlement of Bakiga in Western Uganda |
| V. F. Amann | M. Lawrence | M.Sc. | x | | Urea as a supplemental source of nitrogen for dairy cattle in Uganda |
| O. J. Abbott | M. W. Okot | M.Sc. | x | | Investigations into the use of native beer residue and brewery by-products |
| D. L. McIlroy | C. Baliddawa | M.Sc. | x | | Plant resistance to the sorghum shoot fly (Atherigona sp.) in some sorghum varieties and interaction with chemical treatment |
| D. L. McIlroy | D. K. Zinabiene | M.Sc. | x | | Effect of environmental factors and feeding regimes on pasture utilization by dairy cattle. |
| P. G. Moe | P. Nkedi-Kizza | M.Sc. | x | | A hydraulic Lysimeter study of the water use of the banana plant at Kabanyolo University Farm |
| P. G. Moe | V. I. Machado | M.Sc. | x | | A study of the climate and nutritional factors affecting the growth and yield of sugar cane in an area of Uganda |

Table 8. Showing Contract Staff Member Involvement as Supervisors and Examiners of Postgraduate Students, June, 1971. (Continued)

| Staff Member | Student | Degree | Supervisor | Examiner | Research Project |
|---|---|---|---|---|---|
| P. G. Moe | M. A. H. Jones | M.Sc. | x | x | The importance of moisture and nutrient placement in determining the availability of nutrients to plants in red tropical soils. |
| P. G. Moe | G. J. Awour-Okulo | M.Sc. | x | | Banana nutrition in Bangenda clay loams |
| R. T. Wurster | A. Msaka | M.Sc. | x | | The development of the Passion Fruit industry in Uganda. |
| R. T. Wurster | W. Jensen (Mrs.) | M.Sc. | x | x | Some technical and economical aspects of horticultural production in Uganda. |
| R. T. Wurster | J. M. Kori | M.Sc. | x | | A survey of the status of Phytophtophora infestans on Solanaceous hosts in East Africa, including assessment of pathogenic races present and cultivars with potentially useful field potential. |
| W. A. van Eck | V. P. D. Costa | M.Sc. | x | x | Interpretation and correlation of air phot features to soils and soil properties on the Kano plains. |

Several staff members examined theses of students during 1970-71 and these degrees should be awarded at next graduation.

1. Dr. P. G. Moe examined the Ph.D. thesis of F. J. Wangati-- A study of water use efficiency in field crops of maize and beans.

2. Dr. F. J. Olsen examined the M.Sc. thesis of E. R. Tikaruhondi-- A study of some method of increasing pasture productivity during the dry season on the northern shores of Lake Victoria, Uganda.

3. Dr. V. F. Amann examined one Ph.D. and two M.Sc. theses during the past academic year:

    a. Ph.D. - M. Hall - A farm management survey of the coffee banana zone in Buganda/Busoga.

    b. M.Sc. - S. H. Jiwani - Agricultural statistics in Uganda

    c. M.Sc. - H. S. K. Nsubuga - Dairy farming in Busoga, East and West Mengo districts of Uganda.

Several of the students remain registered as postgraduates even though their work is completed and passed by the Examiners. The degrees will be awarded at next graduation ceremonies.

The Ph.D. program will probably continue as a dissertation program. The Faculty of Agriculture does not have sufficient staff to mount a course work plus dissertation Ph.D. degree at this time. This may be a future development. For the present, Ph.D. aspirants should be encouraged to study abroad but, whenever possible, they should do their dissertation research in their home country.

## Research Activities

An important objective of Contract AID/afr-411 states:

> The contract staff must be well-versed in programs of research as conducted in agricultural research stations in the United States. They will be expected to strengthen and reorient the present research programs of the College to one which is adapted to East African conditions and related to on-going programs in specialized research institutes.

All the contract staff members except the Chief of Party are engaged in field research activities. Progess reports and publications

LEFT: Dr. Paul Moe charts calculations on nitrogen fertilizer applications.

BELOW: Dr. Moe and student ready banana plants for research project 824/RB, Study of Root Distribution and Nutrient Uptake.

Dr. Willem van Eck spent much time in the field with his irrigation research at Kabanyolo.

ABOVE: Dr. van Eck examines a thermometer of a weather station set up on the farm.

LEFT: Dr. van Eck uses a radiometer to measure solar radiation; how bright and how long the sun shines.

have been written as a result of this research. Research progress reports were given in earlier annual contract reports. This document will include only reports written during the period of July, 1970 to July, 1971.

| Staff Member | Project | Appendix |
|---|---|---|
| Dr. O. J. Abbott and Dr. V. F. Amann | Comparison of strains of chickens for production and marketability of eggs | C |
| Dr. D. L. McIlroy | A study of feeding and management factors which influence milk production and reproduction in exotic dairy cattle in Uganda | D |
| Dr. F. J. Olsen and Dr. P. G. Moe | The effect of phosphate and lime on the establishment, productivity, nodulation and persistence of Desmodium intortum, Medicago sativa, and Stylosanthes gracilis | E |
| Dr. F. J. Olsen | The effect of large applications of nitrogen fertilizer on the productivity and protein content of four tropical grasses | F |
| Dr. P. G. Moe | A study of root distribution and nutrient uptake of the banana plant | G |
| Dr. W. A. van Eck | Kerita tea irrigation project | H |
| Dr. R. T. Wurster and Dr. P. G. Moe | The response of mulched pineapple to urea nitrogen applications | I |

West Virginia University staff members are involved in other research projects with fellow faculty members or postgraduate students. Table 9 presents these projects.

Two new projects were started during the year in which contract staff were involved. These are presented in Appendix J. Dr. Olsen was involved in a study "The Mineral Composition of East African Grasses and Legumes."

Dr. McIlroy is part of a team which is studying "Factors Influencing Silage for Dairy Cows in East Africa--The Nutritive Value of Maize Silage and Silage from Other Grass Species."

Dr. Wurster presented a budget request and justification for a "Potato Improvement Project for Uganda" (Appendix K).

During the last two years of the contract the West Virginia University staff members wrote a fairly large number of research papers which were as follows:

V. F. Amann. "Factors Affecting Present and Future Supplies of Animal Protein in Uganda" - a chapter of a book Food and Nutrition in an African Economy, edited by Amann, Belshaw and Stanfield.

V. F. Amann. R. D. R. Number 99. "A Preliminary Investigation into the Economics of Game Animals as an Alternative Method of Land Use, With a Proposal for an Investigation Into the Problems of Marketing Game Mean."

V. F. Amann. "An Ethiopian Vegetable Marketing Cooperative Used for Research and Teaching - A Case Study."

V. F. Amann. R. D. R. Number 107. "Smallholder Dairy Farming in Uganda with Special Reference to an Intensive Dairy Smallholding at the Veterinary Training Institute, Entebbe."

V. F. Amann. "Experiences in Smallholder Dairy Production in Uganda as a Basis for Setting Production Policy Objectives."

V. F. Amann. Book Review of Dairy Husbandry in East Africa by Richard Musangi to be published in the "East African Journal of Rural Development."

V. F. Amann. Book Review of Milk Production and Marketing in the Tropics by M. C. Simpson and El Hadari to be published in the "East African Journal of Rural Development."

R. T. Wurster and W. V. Jensen (Mrs). "The Role of Horticulture in Agricultural Diversification in East Africa." Presented at the First East African Horticultural Symposium.

R. T. Wurster and S. Nganga. "The Effect of Staking and Pruning on the Yield and Quality of Fresh Market Tomatoes in East Africa." Presented at the First East African Horticultural Symposium.

J. Kori and R. T. Wurster. "Potato Improvement in Uganda, Part I: Identification of the Races of Phytophthora infestans and Selection for Resistance to Late Blight."

K. O. Rachie and R. T. Wurster. "Potential of Pigeon Peas as a Horticultural Crop in East Africa." Presented at the First East African Horticultural Symposium.

P. G. Moe and K. O. Rachie. "Preliminary Results in Pigeon Pea Improvement." Presented to the Twelfth Annual Meeting of the Specialist Committee on Agricultural Botany.

F. J. Olsen and P. G. Moe. The Effect of Phosphate and Lime on the Establishment, Productivity, Nodulation, and Persistence of Desmodium intortum, Medicago sativa, and Stylosanthes gracilis. East African Agric. For. J. (To be Published in the July, 1971 issue).

P. G. Moe. "Kinetics of the Microbial Decomposition of the Herbicides IPC and CIPC." Environmental Science and Technology 4:429-431. 1970.

R. E. Nelson. R. D. R. Number 85. "Some Ideas on Institution Development."

R. E. Nelson. "Sample Characteristics and Cross Relationship of a Baseline Survey of Uganda Agriculture." Extension Saturation Project Report.

W. A. van Eck. Agrometeorology Kabanyolo. 1965-1967-1968.

W. A. van Eck. Agrometeorology Kabanyolo, 1968-1969-1970.

W. A. van Eck. Agrometeorology Series, a Monthly Faculty Release.

Table 9. Research Projects Which Involve West Virginia University Contract Staff at the End of Contract 411, June, 1971.

| Staff Members | Title of Project |
|---|---|
| E. R. Watts, Project Leader<br>J. P. G. Webster, J. J. Oloya,<br>V. F. Amann, D. Sengundo | Kabanyolo Experimental Small Holdings |
| M. W. Okot<br>O. J. Abbott | Investigations into the use of native beer residues and brewery by-products in poultry feeds |
| J. S. Mugerwa, P. K. Stigsen,<br>D. L. McIlroy | Nutritive value of maize and other tropical grass silages |
| J. S. Mugerwa, D. A. Christensen,<br>D. L. McIlroy, H. H. Nicholson | Grazing patterns and pasture utilization by Bos Taurus dairy cattle in Uganda |
| D. L. McIlroy, J. S. Mugerwa,<br>P. K. Stigsen | Feeding and management factors influencing milk production and reproduction in exotic dairy cattle in Uganda |
| P. G. Moe, V. N. Mwoga,<br>P. Khedi-Kizza | The nutrient requirements of bananas. |
| P. G. Moe, W. A. van Eck,<br>G. S. K. Luyigu | A study of the nitrogen and water requirements of tea in Buganda |
| P. G. Moe, K. V. Isaacs | The interaction of silica and calcium on the response of sugar cane and phosphorus. |
| P. G. Moe, R. T. Wurster | The response of mulched pineapple to urea nitrogen applications |
| F. J. Olsen, P. G. Moe | The nutrient requirement of elephant grass (Pennisetum purpureum) |
| K. O. Rachie, P. G. Moe | The nutrient requirement of pigeon peas (Cajanus Cajan.) |
| P. G. Moe, P. Nkedi-Kizza | The nutrient requirements of bananas under irrigation |
| P. G. Moe | The efficiency of nitrogen fertilizer utilization by sugar cane. |

Table 9. Research Projects Which Involve West Virginia University Contract Staff at the End of Contract 411, June, 1971.

| Staff Members | Title of Project |
|---|---|
| P. G. Moe, H. Ssali | The effect of fertilizer placement on uptake of radioactive phosphate by bananas |
| P. G. Moe, P. Nkedi-Kizza | The consumptive use of water by bananas |
| P. G. Moe | The effect of green manuring in sugar cane production in East Africa |
| J. S. Mugerwa, F. J. Olsen, S. V. Songi | Nutritive evaluation of forages in Uganda |

## Conferences

Dr. V. F. Amann was elected the Secretary to the East African Agricultural Economics Society and organized the 1971 conference held in Nairobi, Kenya, June 23-25. Twenty papers were presented which he will edit for the proceedings issue. He is also editor of the *East African Journal of Rural Development*.

Dr. R. T. Wurster was the coordinator of the First East African Horticultural Symposium held on February 23-24, 1970. The symposium was attended by over 75 people from six countries. Thirty-five papers were presented at the meeting which will be published in *Acta Horticulturae*, a publication of the International Society for Horticultural Science.

International Conferences were attended by several staff members during the last two years of the contract. The cost of travel was covered by USAID and conference expenses were covered by Makerere.

| | |
|---|---|
| Dr. P. G. Moe | The Third International Congress on Global Impacts of Applied Microbiology - Bombay, India, December 7-12, 1969. |
| Dr. F. J. Olsen | The XI International Grassland Congress - Queensland, Australia, April 13-23, 1970. |
| Dr. V. F. Amann | XIV International Conference of Agricultural Economics - Minsk, U.S.S.R., August 24 - September 2, 1970. |
| Dr. O. J. Abbott | 14th World's Poultry Science Congress - Madrid, Spain, September 6-12, 1970. |

(See Appendix L for reports on the last three International Conferences attended by West Virginia University staff members.)

Staff members also attended conferences in East Africa; the cost of attendance and travel was shared by USAID and Makerere in all cases.

## Contract Consultants

In addition to regular staff to fill established positions in the Faculty, the contract provided monies to supply short-term consultants to the Faculty for specific short-term assignments.

The McFarland-Turner report recommended a specialist be sent to Makerere to study the needs of the library at Makerere.

Dr. Robert Munn, Director of Libraries at West Virginia University was at Makerere from July 24 to August 14, 1967 and made recommendations on the library. His report was appended to the Progress Report USAID/afr-411, July 1967 to June 1968. The proposals of this report were implemented over the life of this contract.

The McFarland-Turner report also recommended that a specialist in audio-visual materials and equipment be appointed for a one-year

Dr. James G. Harlow, President of West Virginia University, made his first visit to Makerere University in August, 1971. During his visit he was able to make observations and discuss WVU contract staff research projects with the staff.

ABOVE RIGHT: Dean McIlroy, Okra Abbott, Victor Amann, President Harlow, Paul Moe, and Richard Wurster.

LEFT: Farrel Olsen, Okra Abbott and President Harlow.

period. It was decided by USAID and Makerere officials that it would be more appropriate to use the services of a short-term consultant to survey the needs and available equipment and to advise the Faculty on the types and kinds of equipment to be purchased and to conduct training sessions for faculty members on the use, operation and maintenance of equipment. Mr. Hugh Cameron, Editor, International Programs at West Virginia University, was in Uganda from August 20 to October 15, 1967 to accomplish these objectives. Over one-half of this period was spent with the Faculty of Agriculture at Makerere and the remainder of his time was spent at diploma colleges. Mr. Cameron's report is included as an appendix to the 1967-68 USAID/afr-411 Progress Report.

These consultations were very helpful in crystalizing and implementing some of the early recommendations for the faculty. They presented expert views on needs in specific areas and presented an overall look at needs of the Faculty and the University.

Other consultants came to Makerere from West Virginia University to consult with contract staff members on specific projects. Dr. Mannon E. Gallegly, Professor of Plant Pathology, West Virginia University was in Uganda in April, 1969 to consult in a potato improvement project for Uganda. Dr. R. T. Wurster later implemented the recommendations and is now working with the Ministry of Agriculture to develop high yielding, late blight resistant varieties and to produce disease free foundation and certified seed of these varieties.

## West Virginia University Contribution

West Virginia University believes that the contractual arrangement has provided the opportunity for additional benefits to both institutions. Faculty members who have served on the contract team at Makerere have returned to the home campus at Morgantown with additional experience and expertise that have been incorporated into the program

Mutual interests have been generated between staff at Makerere and Morgantown that will persist and benefit both institutions long after the contract has been terminated.

In early 1970, Dr. R. L. Reid from the Department of Animal Industry and Veterinary Science, West Virginia University came to Makerere to work with Dr. F. J. Olsen in setting up the laboratory facilities for nutritive evaluation of forage samples by in vitro and chemical analyses. Initial trials were designed to test the reproducibility of the systems. Analyses were made on grasses fed in digestibility and intake trials on sheep. The work was done on 40 tropical grasses and 12 legumes taken at weekly intervals during a 16-week growth period.

LEFT: Dr. Paul Moe and Robert Heusman view cut sugarcane.

BELOW LEFT: Drs. Farrel Olsen and Newton Baughman inspect Olsen's grass plots during a recent inspection trip by Baughman to East Africa.

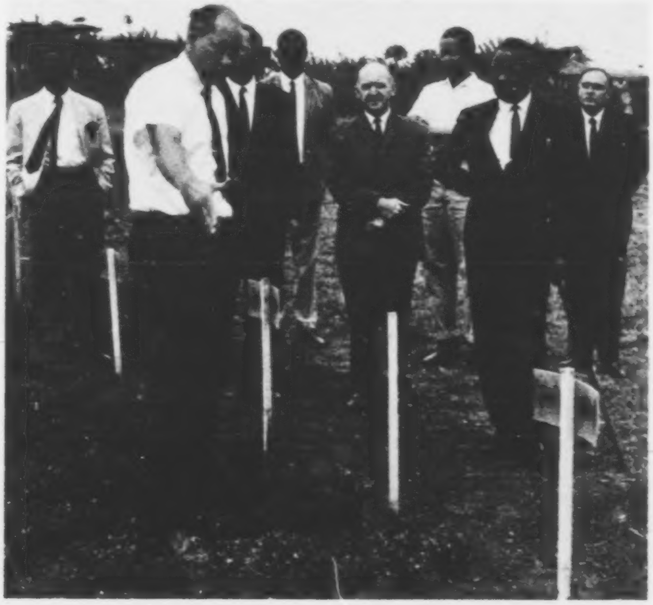
BELOW RIGHT: Mr. Rex Ottley, USAID/Uganda, samples strawberries from Dr. Richard Wurster's experimental plot.

Dr. Farrel Olsen is seen above with
Dr. E. J. Nesius (former WVU Vice Pres.
for Off-Campus Educ.) during Nesius'
visit to Makerere.

Above Right, Dr. Olsen examines alfalfa productivity effected by different levels of phosphate.

Left Below, Dr. Olsen and Dr. R. L. Reid (WVU) take grass samples during Dr. Reid's research project visit to Makerere.

Right Below, Dr. Olsen shows Makerere visitors his research plots.



Samples of grasses and legumes, numbering nearly 200, were sent to West Virginia University for complete mineral analysis. The evaluation of feeding tropical legumes and later elephant grass was a basis of determining feeding potential. This project was funded by West Virginia University and Makerere University.

A technician from West Virginia University, Miss Amy Post, accompanied Dr. R. L. Reid. She remained at Makerere for three months. While at Makerere she assisted in training Ugandan technicians in the procedures used at West Virginia and modifying them to Ugandan conditions.

Dr. H. A. Gibbard, Head of the Department of Sociology, took leave from West Virginia University and went to East Africa in January, 1968, to evaluate the relevance of East African students' West Virginia University experience for their subsequent work experience in their home country. Dr. Gibbard's salary was continued by the University. Travel and other necessary expenses were funded through the Office of International Programs. Dr. Gibbard returned to West Virginia in August, 1968. A confidential report has been prepared and submitted to USAID and Makerere University College.

In May 1968, Mr. P. J. Faini, Assistant Professor of Music, conducted a research project on percussion instruments in East Africa. This project was a joint effort between the Office of International Programs and the Department of Music. In addition to a study of African music, Mr. Faini collected instruments for an ensemble at West Virginia University. One paper, "African Drumming", has been published in the Ludwig Drummer, Volume 8, Number 2. Other papers are in preparation. He, with Dean Richard Duncan, Creative Arts, again returned in June and July, 1971 to do further research.

Other colleges and divisions of the University have shown an active interest in East Africa. Dr. Wesley Bagby, Professor of History, spent six weeks in East Africa gathering information on diplomatic relationships between the United States and African countries. This information will be included in a text Dr. Bagby is preparing for secondary schools. Dr. Bagby's trip was financed by the Office of International Programs.

The Division of Social Work, College of Human Resources, West Virginia University, have been in contact with social workers at Makerere University College, Nairobi, and University College, Dar es Salaam. Drs. H. L. Grochros and D. P. Williams traveled to East Africa in June - July, 1969, sponsored by the Office of International Programs. They were able to develop plans for cooperation between their division and social workers in East Africa for student family exchange in this vital area of development.

Dr. Leon Ginsberg, Director of the Division of Social Work made a visit to Makerere in June, 1970 to follow-up the work of his staff members of the previous year.

Other projects were undertaken through International Programs Office auspices, many were not as closely related to Makerere as those mentioned here.

West Virginia University is a charter member of the Regional Council for International Education located at Pittsburgh, Penn Pennsylvania. West Virginia University has worked closely with the Regional Council for International Education to develop effective relationships with East African Universities. Plans are underway to develop faculty seminars, teacher exchange and student experience in Africa through the Regional Council for International Education. Dr. Rodger Yeager, Department of Political Science, West Virginia University, brought a group of college teachers to Makerere in 1970 for a two-week seminar under the Offices of International Programs, West Virginia University, Regional Council for International Education and the Office of Health, Education and Welfare.

## Institution Building

In the words of Dr. John Hannah: "The most effective and enduring contribution to human development is through the building of indigeneous educational institutions which will enable a nation to help itself by educating its own people to enter and sustain themselves in the modern world".

The rather specific objectives of the contract are stated in terms that permit finite measurement of progress made toward the attainment of the objectives. The implicit objective of the contract, however, was to assist the Faculty of Agriculture in developing as an institution, in the classical sense of the term, such that it will perform the functions stated by Dr. J. Hannah.

It remains that although a theory has been developed concerning factors involved in institutional building, and many of the elements have been identified, no unifying law has been developed that has received universal recognition.

Although the individual building blocks needed to construct an institution are subject to debate, the general characteristics of an institution can be described. The first and most important characteristic is that it be viable. Viability of an institution is the sum of many factors: The degree to which individuals and organizations within the community it serves look to the institution for information and guidance, the degree to which the individual goals of staff members are the goals of the institution, the manner in which the staff members of the institution are identified--as members of the institution rather than as individuals--and community acceptance of the products of the institution--its graduates, research data and counsel. In sum, the viability of a developmental institution is its ability to exist and to perform as en entity; its accomplishments must be attributed to the institution, not to any individual member. It must be self-sustaining, deriving fuel from internal sources continuously regeneraged.

Dr. Ralph Nelson, in the 1968-69 progress report of this contract, hypothesized that the following structural characteristics are essential for a developing institution:

1. Clearly defined goals
2. Democratic decision-making processes
3. Mature and experienced leadership
4. Delegation of responsibility and authority
5. Adequate physical and fiscal resources
6. A staff improvement program
7. Continuous program review
8. Linkages with other institutions with similar goals

Dr. Nelson estimated the degree to which the Faculty of Agriculture had acquired these characteristics as a measure of the progress made toward achieving the objective of assisting the Faculty in becoming an institution.

We have shown the progress made toward achieving the explicit objectives of the contract. Progress made toward achieving the implicit objectives of building an institution can be illustrated by ascertaining the progress made toward establishing in the Faculty of Agriculture Dr. Nelson's hypothesized characteristics of an institution.

## Clearly Defined Goals

The goals of an institution must not only be understood and accepted by those individuals who are members of the institution, they must also be understood and accepted by individuals and organizations external to the institution. The goals of the Faculty of Agriculture have been and are (1) to provide an educational environment wherein students, both undergraduate and postgraduate, can learn the Agricultural Sciences and can become capable of planning and implementing the development of agriculture as an economic entity in East Africa in general and Uganda in particular and (2) to develop a program of agricultural research that will compliment the research performed in other research stations and lead to the solutions of problems restricting the development of agriculture in East Africa.

The educational goals of the Faculty have been accepted by all concerned. Government and parastatal agencies look to the faculty as a source of high level manpower to fill vacancies in their establishments. The developmental plans of the Faculty have been approved by the Administration of the University and by the Government of Uganda. Thus the Faculty can look forward to increased numbers of faculty members, increased number of curricula and increased number of students in the immediate future.

A word of caution is perhaps needed at this point. In recent discussions with members of the various Ministries employing graduates of the faculty, there has been some indication that graduates have not been given instruction needed to perform the details of the various positions to which they have been posted. This perhaps is so. The breadth of the field of agriculture and the variety of positions available to the new graduate makes it impossible for any faculty to provide in its instructional program the details of every position to which a graduate might be posted. We might state the educational goals of the Faculty in the following manner: To provide an educational environment in which the prospective graduate can learn the art, science and practice of agriculture such that he can "with minimum in-service training" adapt his educational background to perform the duties and assume the responsibilities of any of the several positions requiring a degree in agriculture as an entry qualification. The success of the Faculty in achieving its educational goals will be measured by how rapidly each individual can learn and perform the duties of any specific position. We state this in all candor believing the responsibility of an educational institution is to provide the tools for the profession. The individual will then be assisted by his supervisors in selecting from the tools provided those needed for a specific position.

The research goals of the faculty were less clearly recognized by agencies external to the faculty in 1968 than were the educational goals. Since that time the faculty has consolidated a postgraduate program which has, as an intregal part, the supervision of research work by postgraduate students. Research facilities in the field and in the laboratory have been made available. The faculty have developed research projects that have been approved and partly supported by the Ministry of Agriculture and Cooperatives. A national research committee has been formed. This committee has recognized the activities and the future potential of the Faculty of Agriculture in fundamental as well as applied research. The Faculty has, in turn, established a research committee that serves as a coordinating committee for research in the Faculty and as a liaison to the national research committee.

## Democratic Decision-Making Processes

The term "democratic" when applied to decision making may have varied interpretations depending on the individual using the term. In the context of the present discussion we mean a decision reached in which the views of all concerned are given due consideration with the ultimate aim of attaining the goals of the institution without prejudice to any individual or group of individuals. The decision-making process existing in the faculty when the contract was initiated, and inherent to a small group of individuals, was probably ideal. As the size of the faculty has increased the changes that have been made in the government of the faculty have essentially maintained the democratic nature of the decision-making process. The initiation of a committee procedure as delineated by Dr. R. Nelson have probably slowed the process but has not detracted from its democratic nature.

## Mature and Experienced Leadership

In a rapidly developing society where in the past leadership and administration have been imposed from external sources, it is inevitable that there will be severe pressures exerted to replace the former expatriate leadership with new faces, local in origin. It is to the credit of the Government of Uganda that these pressures have been successfully resisted. It is true that the former expatriates have, for the most part, departed the scene. However, they have been replaced by others, provided in part, by external donors. The experience and maturity of the Faculty is being maintained while a "pipe line" of Ugandans is being developed that will, in time, assure a continuation of maturity and experience in the leadership of the Faculty.

## Delegation of Authority and Responsibility

A quality inherent to a viable institution is that those individuals and administrative sub-units making up the institution will be delegated authority commensurate with the responsibility assigned to them. The assignment of responsibility is a function of the leadership of the institution and should be made with as complete knowledge of the capabilities of the people concerned as is possible. The rapid development of the Faculty over the past eight years would attest to the fact that authority and responsibility have been assigned in an adequate manner. The development of the committee structure within the administrative operation of the Faculty will assure that this will continue.

## Adequate Physical and Fiscal Resources

The acquisition of adequate fiscal and physical resources requires an input from sources external to, but not dissociated from, the institution. These supportive sources have accepted the goals of the institution. They must also be shown, realistically, the resources needed to achieve the goals of the institution. Dr. R. Nelson has detailed the present sources of support external to the country. In securing external sources of funding for staff and physical additions to the facilities of the Faculty, the governing body of the university and the Government of Uganda have made commitments to provide the recurrent costs now and to continue support for future development.

## Staff Improvement Program

The program of assistance, of which this contract was a part, had a component for the training of replacements for the temporary staff members provided under the contract with West Virginia University. Through this program, the USAID would provide funding to send selected individuals to the United States for higher degree programs as preparation for the individuals concerned to return to established positions in the Faculty. Further arrangements were made with the Rockefeller Foundation to establish "special lectureships" as supernumerary positions within the faculty where essentially double-staffing in certain positions was provided. In this manner, young Ugandan staff members could serve in a probationary and apprentise role while becoming prepared to assume a position to be vacated by a short-term contract employee.

Staff members are provided the opportunity and encouraged to attend professional meetings in their professional field, both in Africa and abroad, to increase their professional competence. A program of staff exchange is being developed with other universities. In this program, Uganda staff members may trade places with a staff member in a similar position from another university for a period up to a year.

## Continuous Program Review

Through the period of time covered by this report, momentous changes have occurred in the program of the Faculty. The undergraduate curriculum has been changed three times, the postgraduate program has been changed twice, the research program has been continuously under study and review. Each of these changes have been preceeded by in-depth study by special committees of the Faculty and have been initiated only when the studies have been reviewed critically by the administration of the University and the Faculty. The standing committees of the Faculty are charged by the terms of their appointment to review the programs under their jurisdiction and report to the Faculty suggestions for improvement and effectiveness. There are several entities external to the Faculty that act in a capacity of program review. These include a Visiting Committee to the University appointed by the President of Uganda, The University Grants Committee that reviews and recommends the budget of the University and its constituent Faculties. Further, there are various government and parastatal agencies providing bursaries for students that are expected to employ graduates of the Faculty and also to provide and stimulate program review.

## Linkage With Other Institutions Which Have Similar Goals

Linkage may be of many types. In the sense of institution-building theory, linkages are those relationships with other institutions in the larger society of which it is a part. These include "enabling linkages" through which the institution receives the authority, permission and resources that permits it to operate and "functional linkages" that permit the product(s) of the institution to be used by society. Although not in the context of the term "linkage" as defined in the original theory of Institution Building (but covered in the general heading of "Transactions"), we have used the term linkage to indicate those relationships of a catenary nature existing between similar organizations that must be present if these similar organizations are to survive and become "Institutionalized".

These relationships must be mutually beneficial if they are trully linkages. Linkages of this nature, not previously discussed, include those between the Faculty of Agriculture and the Faculty of Education where they have joined to provide a program to produce teachers of agriculture in secondary schools, and the relationship between the Faculty of Agriculture and the Faculty of Arts in which students in Economics may take a major in the field of Agriculture Economics. The government has established a council on research which permits a greater and closer relationship to be developed between the Faculty and government agriculturally-related research stations. When the University of East Africa was dissolved, the three independent universities resulting tended to drift apart. Now the separate Faculties of Agriculture are developing mutually beneficial relationships involving student and staff exchange, providing external examiners and exchange of research information.

Through the doors of Makerere University's Administration Building enter and leave many young men and women. It is the hope of West Virginia University that we have been able to aid Makerere, through USAID, in its service to these leaders of tomorrow.

## SUMMARY AND CONCLUSIONS

There have been some sweeping changes in the Faculty of Agriculture during the period of this contract. The traditional type of training based on old European standards of instruction has been replaced by a new syllabus which includes course units, continuous assessment and provides a better balance between science and agriculture subjects during the first year.

The course units provide a method of breaking the subject of agriculture into units. These units have boundaries that make it easier for instructors to delineate the material and for students to more easily understand the development of material in a subject through a sequence of blocks of learning. All course units in the various departments were developed to teach the students the material in a described area and each course is an integrated part of the whole. The course unit system provides a framework for structuring courses to facilitate learning.

The expansion of the practical teaching program has helped in improving opportunities for students to get experience in practical application of classroom material. The revised syllabus in 1971 provides for a greater variety of field practical training including experience on small farms, large government institutions and Kabanyolo Farm. It also provides for a longer period of practical training plus a pre-entry practical training requirement.

The acceptance of the course unit examinations and continuous assessment have provided a large break with the tradition of placing the entire evaluation of the students' performance on comprehensive examinations. In the first curriculum revision (1968) up to 33 percent of the final mark could be based on continuous assessment. This was raised to 50 percent in the 1971 syllabus. The elimination of three-hour examinations at the end of the first year and the change over to complete internal examinations by the course lecturer was also a new and improved method of determining student performance.

The number of comprehensive examinations was reduced in the 1968 syllabus and to be given only at the end of the second and third years. This was further reduced in the 1971 revision when the number of comprehensive examinations was reduced from a total of 11 to 7 in the two years. The rationale for this was that the 50 percent weight given to continuous assessment provides a basis for evaluating student performance. The final examinations become more a basis for classifying the degree.

The number of options available was increased. In the pre-contract period there were no options. The 1966 syllabus revision provided two options. In the 1968 syllabus, a management option was inaugurated and another option was made available to students who were working on a diploma in education; this will start in 1971-72 academic year. The Forestry Department was added to the Faculty in 1970 and has students in first and second years at this time.

The addition of Forestry and Education students will add to the teaching load because many of the courses taken by these students are in cooperation with B.Sc. (Agriculture) students. There are also a fairly large number of 3.2.2 and 3.1.1 students from the Faculty of Arts and the Faculty of Social Sciences who are taking courses in agriculture especially in the Department of Rural Economy and Extension. During the periods of 1969-70 and 1970-71, there were approximately 50 students from that source.

The administration and government of the Faculty has changed considerably during the period of the contract. Formerly, the Faculty Board was the only sounding board in the Faculty. In recent years, sub-committees were formed where ideas were debated and proposals developed and formulated for consideration by the Faculty Board. The Board of Undergraduate Studies worked out the revisions in the syllabus. Postgraduate Studies Board developed the new syllabus for the M.Sc. and makes recommendations on postgraduate student applications. The Research Committee has the job of looking at and determining the relevance of research proposals as well as checking a progress of ongoing research.

There are other committees. The Staff Liaison Committee provides opportunities for students to communicate their problems to the Faculty. There is also a student representative on the Board of Undergraduate Studies. The Farm Advisory Committee makes proposals on the operation of the University Farm and the Open Day Committee makes arrangements for the annual field day at Kabanyolo. West Virginia University staff members served on all committees.

The position of the Dean was changed from that of an elected Academic Dean whose primary function was to chair committees and to represent the Faculty on university committees. The new Dean's position is one of a full time Dean who provides the administrative function of the Faculty and who has greater opportunity to provide leadership with a greater amount of authority.

The development of a postgraduate syllabus was a departure from the former dissertation degree. It provides a course unit program to provide students an opportunity to study subjects in greater depth and to obtain a better grasp of analytical tools needed for their research. This should result in a greater amount of analysis in theses in the future and reduce the number of descriptive theses.

Students numbers at the undergraduate and postgraduate level increased greatly. At the end of the contract, there were 217 undergraduates enrolled and over 50 postgraduate students. The number of graduates has increased from 15 in 1965 to 80 in 1971 which was the target set out in the contract. Staff development has also pressed forward. The total staff has increased to over 40 and the number of Ugandans has increased considerably. There is now a Ugandan professor in the Faculty and four at the Lecturer and Senior Lecturer levels. Several other Ugandans are compelting research for their Ph.D. at Makerere in the capacity of special lectureships and upon completion will return to the Faculty as staff members.

The future development of the undergraduate program should include a four-year curriculum. This would provide greater opportunity for practical training and also give students greater opportunity to specialize. A four-year program would provide opportunities for greater amounts of elective courses so students could study in greater depth their chosen area of interest. Electives were included in the 1968 syllabus but because there were so few they were eliminated in 1971.

The postgraduate program should continue to place major emphasis on the M.Sc. level of training. The Ph.D. will most likely continue to be a dissertation degree but should not be emphasized because of the limited size of staff and as more Ugandans are placed on the staff, the level of experience will fall. This will tend to make the Ph.D. a more difficult program to supervise until experience is developed in postgraduate training. It is suggested that Ph.D. candidates be sent abroad to study, to conduct their research in Uganda and return to complete their degree if necessary. The possibility of joint Makerere and foreign university Ph.D. degree programs should be explored. This would permit students to take course work abroad, then do their research and be examined at Makerere. This would perhaps require joint supervision by Makerere and foreign university staff members.

# Appendix A

## Summary and Recommendations From the McFarland Turner Report, 1965

### A. General

1. A developing agriculture is crucial to the economy of East Africa. A continuing supply of professionally trained manpower is essential to this development. The Makerere University College Faculty of Agriculture is producing competent agriculturalists to contribute to this need. Together with the Agricultural Colleges (Diploma Schools), the Certificate programs and the Farmers' Training programs, all levels of educational effort are represented in the present structure of agricultural education in East Africa.

2. The Faculty of Agriculture is earnest in effort and dedicated to the work at hand. There is interest in the teaching function as well as in research, and evidence of responsibility and concern for the academic welfare of the students at Makerere.

3. The influence of the Faculty of Agriculture at Makerere extends far beyond the confines of the College. Faculty members serve in advisory capacities in a wide variety of government and other public commissions, committees, and study groups. As a result their work loads cannot be measured by the application of the usual standards of class- or student-hour contacts.

4. There are no in-residence graduate students in Agriculture at Makerere, with only a limited number of students registered for the research-only degree. If the staff and program in Agriculture at Makerere University College is to grow and flourish, emphasis must be directed toward the development of a meaningful graduate program. This calls for the addition of staff, laboratories and offices and equipment. Without these developments, staff recruitment will become more difficult and the unique position of Makerere in the East African agricultural education program will deteriorate.

5. The supply of candidates for admission to the degree program in Agriculture should increase with rapidity. The number of schools offering Forms V and VI are multiplying. With the increase in enrollment at the agricultural colleges, more students of superior quality will seek admission to Makerere after having been stimulated to become interested in career opportunities in professional agriculture in the diploma program.

B. Curriculum

1. Graduates in agriculture from Makerere appear to be well grounded in the basic agricultural sciences. There is some question as to the breadth of general education they have experienced, but their technical training is of excellent quality. Some minor adjustments in curricular coverage may be useful as the program develops.

2. The instruction at Kabanyolo Farm should be reviewed in order that a greater intensification of learning experiences might be secured. There would be much merit in considering a reduction in the amount of time each student spends in residence at Kabanyolo.

3. Faculty study should be directed to the advantages that might accrue from the introduction of some degree of specialization into the undergraduate curriculum.

4. A number of advantages would be secured from the development of a more "regularized" undergraduate curriculum outline. These include a better view of the adequacy of coverage, identification of areas in which coordination and cooperation in instruction are possible, and greater ease in scheduling. At the present time no fully developed picture of the undergraduate teaching program, including the contribution from all instructors in the various departments, is available.

5. An in-residence program of graduate studies has much to offer the Faculty of Agriculture. The exchange of ideas, experiences, and techniques with others will aid the graduate students. The massing of the graduate effort in research may create more impact in the scientific, academic, and agricultural community. And possibly most important for the future of Makerere, opportunity will be provided for the encouragement of a loyalty to the institution and an interest in academic life that will lead to the development of potential staff replacements for Makerere.

6. Some acreage should be available to graduate students and to staff members for intensive field plot research. Consideration should be given to allocating field space at Kabanyolo Farm in the amount required. Kabanyolo Farm offers advantages in continuity of use that will not be secured even with the most cordial relationships with nearby government or federated experiment stations. Such use would be highly appropriate for the Kabanyolo Farm, and would not detract in serious degree from its present function.

7. Programs of professional improvement and in-service training for agricultural workers in a particularly appropriate charge to the Faculty of Agriculture, and such efforts may well be included as a basic responsibility of the faculty with time and facilities made available to support these programs.

8. Graduate and staff research programs at Makerere will be enhanced by a continuation of the useful relationships presently enjoyed with the Cotton Research Station at Namelonge and the experiment station at Kawanda. Similar contacts with other programs in Kenya, Tanzania and Uganda will enrich the graduate training program.

## C. Facilities

1. The facilities contained in the Agriculture building are generally adequate to accommodate the student body growing out of an annual intake of 80 students. However, facilities to accommodate in-residence postgraduate students are almost completely lacking.

2. If undergraduate student intake were to exceed 80 students per year, additional construction for undergraduate laboratories would be required.

3. Some adjustments in present space usage to achieve greater efficiency and to accommodate increases in staff and student numbers are possible. These include sectioning of classes, reassignment of office space (in some instances from one department to another), accepting more students into certain laboratories by reducing the bench space per student, and minor renovations in the present structure.

4. The facilities at Kabanyolo Farm are not intensively used at present, and provide for some flexibility in the immediate future, insofar as staff officing is concerned.

5. A major construction and equipping undertaking will be required to accommodate a graduate training program of reasonable size.

6. There are needs for additional equipment for undergraduate instruction in selected areas, primarily Farm Mechanization and Animal Physiology.

7. Staff office space (or office-laboratories) is a shortage item and must receive consideration in any planned construction. The present structure will permit only a limited amount of doubling-up in the use of offices and laboratories.

8. A change in the program of Year II students, if accepted, would make it unnecessary to construct additional student hostels at Kabanyolo Farm. Such an adjustment is strongly recommended.

9. The local housing situation makes it essential that provision be made to house the families of incoming members of staff. Additional housing units should be added at Kabanyolo.

D. Staffing

1. The staffing situation is presently in an uncertain state. Staff turnover is rapid and recruitment of expatriate personnel is increasingly difficult. The existing vacant positions in the establishment have thrown heavy loads on some members of the staff.

2. Additional specialists are needed in certain important areas to provide minimum essential coverage for a university program in Agriculture.

3. Very few qualified African candidates are available at present to fill staff vacancies, nor does the supply appear assured for the period of perhaps 5 years. An intensive program of selection of promising candidates plus overseas graduate training pointing towards the appointment to specific staff positions would appear to be necessary to prepare African students for university teaching responsibilities in Agriculture.

4. Some regularized alternative source of staff supply for this 5-year interim period should be sought. A contractual relationship with an established program may be the most useful means of securing continuity of purpose and direction during the critical period ahead.

5. With an anticipated doubling of entering students from 40 to 80, corresponding increases in junior staffing will be required.

6. Senior staff members may wish to give thought to ways in which in-residence graduate students may gain experience through giving assistance in classroom and related procedures. This teaching apprenticeship under careful supervision could well be an excellent aid in staff recruitment, and could provide an important basis for evaluating the qualities of a potential staff member.

## E. Other

1. The leadership stemming from a permanent Deanship should be sought, in the interests of securing a more aggressive expression of total faculty needs, of more continuity in policy and administration, and to secure greater coordination in the teaching, graduate training and research efforts of the faculty.

2. The absence of audio-visual materials or facilities suggests that a qualified individual should be sought for a limited period of perhaps one year to assist in the development of audio-visual materials for use in teaching and to train staff personnel in the use of such equipment and materials.

3. The present library holdings are not adequate to support a modern and growing program of agricultural science. Services of a qualified agricultural librarian should be secured to conduct a thorough library survey and to advise as to the library needs of the Faculty of Agriculture. This is a serious deficiency and library holdings should increase together with growth in staff, students, and facilities.

Appendix B

# ANNUAL PROJECT REPORT, 1970-71
MAKERERE UNIVERSITY, FACULTY OF AGRICULTURE
DEPARTMENT OF RURAL ECONOMY AND EXTENSION

## RESEARCH PROGRAM: FARM MANAGEMENT

### TITLE

R.E. 2-2: Kabanyolo Experimental Small-Holdings

### DATES OF INITIATION AND COMPLETION

The first small-holding was started at Kabanyolo in January, 1968. The project is a long-term one and has no exact date of completion. Rockefeller funding will, it is hoped, continue for at least two to three years. These funds are largely for the creation of new small-holdings. Once established the small-holdings can continue with a very small annual budget for record keeping and supervision of records.

### PERSONNEL

Project Leader: E. R. Watts
J. P. G. Webster
J. J. Oloya
V. F. Amann
D. Sengendo
Plus farmers listed in Section 6

From time to time meetings are called to consider specific problems or to plan new holdings. For these meetings, appropriate government and Makerere staff are invited to participate.

### SOURCE OF FINANCE

Rockefeller Foundation

### SUMMARY OF PREVIOUS WORK

Up to the end of 1969 only one small-holding had been started at Kabanyolo. The Luteete small-holding is reported on separately. Both small-holdings have had their teething problems but the experience has been useful in planning Small-holdings 2 and 3. Details of the early experiences on Small-holding Number 1 are contained in R.D.R. Paper Number 75.

## PROCEDURES AND ACTIVITIES DURING THE YEAR

During 1970, two new small-holdings have been started so that the present (June, 1971) position is:

| | Number of Small-Holding | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Date Started | January, 1968 | January, 1970 | November, 1970 |
| Name of Farmer | Mr. Lwanga | Mr. Kitya | Mr. Sekimpi |
| Main Enterprises | Dairy Cattle (Stall Fed)<br>Coffee<br>Bananas<br>Vegetables | Vegetables<br>Bananas<br>Pineapple<br>Paw Paw<br>Passion Fruit | Dairy Cattle (Grazed)<br>Bananas |
| Labour Supply | Farmer, Wife and 1 Labourer | Farmer and 2 Labourers (1 on experiment) | Farmer Only |
| Approximate Farm Capital Requirement Uganda Shs. | 4630/- | 4730/- | 6415/- |
| Size (Acre) | 5 | 5 | 5 |

From the start housing has been excluded from the loan element on the assumption that the (hypothetical) local farmer has a house. Small-holding Number 1, in fact, uses the original house of the previous tenant who was bought out in 1967 at a cost of approximately Shs. 2800 (house and land). Both Small-holdings 2 and 3 have houses built from murram blocks. Details of housing costs are as follows:

## HOUSING

| | Number 1 | Number 2 | Number 3 (Estimate) |
|---|---|---|---|
| Improvement to existing house | 1200 | ---- | ---- |
| Construction of new house (murram blocks) | ---- | ---- | ---- |
| Kitchen | 500 | 1450 | 1500 |
| Toilet | 300 | 360 | 400 |
| Water tank | 450 | 500 | 850 |
| Total | 2450 | 7310 | 7950 |

Farm development costs have tended to increase seriously with Small-holding Number 3, and it is doubtful whether a loan in the range of well over Shs. 1000 an acre would over be possible.

## FARM DEVELOPMENT

| | Number 1 | Number 2 | Number 3 (Estimate) |
|---|---|---|---|
| Cowshed and water tank | 1200 | ---- | 1000 |
| Clearing land by hand (employed labour) | 300 | 3800 | ---- |
| Tractor hire | 230 | 330 | 525 |
| Sundry equipment | 300 | 250 | 400 |
| Planting material | 100 | 350 | 290 |
| Fencing | 400 | ---- | 2250 |
| Cattle (3 half bred cows) | 2100 | ---- | 2100 |
| Total | 4630 | 4730 | 6565 |

The high risk factor involved in dairying was emphasized by the fact that one heifer died a few weeks after arrival from East Coast Fever. A cow on Small-holding Number 1 has suffered seriously from Anaplasmosis on two occasions. Small-holding Number 1 has also suffered severely from irregular breeding performance. The first Nganda x Jersey cow was sold in November, 1970 (for Shs. 650) after being dry from January. A special meeting to advise on management was called and the problem is still under consideration by the Department of Animal Science. Detailed yields etc., are as follows:

| | | Jersey x Nganda | Fresian |
|---|---|---|---|
| Price of cow (Shs.) | | 700 | 2100 |
| Lactation yield (lbs) | 1* | 4087 (305) | 6100 (342) |
| | 2* | 7000 (305) | |
| | 3* | 6021 (305) | |
| | 4 | 4816 (235) | |
| | 5 | 3080 (299) | |

(Days in brackets)

*These lactations at Nyakesasa Livestock Station.

One of the functions of the small-holdings in addition to testing new farm systems is to test individual innovations for use on peasant farms. Amongst the innovations tested to date are the following:

INDIVIDUAL INNOVATIONS TESTED 1968-1970

| Innovation | Problems | Notes |
|---|---|---|
| Spraying with Dowpon (Cost 110 Shs/Acre | Timing. Heavy cost and probability of second treatment | Used spasmodically b/c cost. May be better to uproot coffee |
| Spraying with Gramoxone (Cost 30 Shs/Acre | Only kills top growth of Couch Grass | Used regularly--coffee yields improved despite Couch |
| Hybrid Grass (Elephant Grass x Finger Millet) | Vary variable planting material with first trial | Going to try again using more tested material |

| | | |
|---|---|---|
| Automatic water trough and 1000 gallon tank | With 2 cows gets dry after about 3 weeks without rain | Experimenting with larger tanks |
| Wheel barrow for grass carrying (Cost 25 Shs) | Sticks in muddy conditions not suitable for manure | Experimenting with metal lining for manure |
| High leaf yield variety of sweet potato--obtained from Embu, Kenya | Vegetable propagation makes extensive use slow. No information on yields (In Embu 80 tons/acre/annum) | Recommended to Crop Science for yield and composition trials. Local farmers are buying planting material. |
| Fertilizer--use of Sulphate of Ammonia on Coffee and El. Grass | Used at rate of 1 cwt/acre. Main problems are cost and transport | Only used when income from milk high and grass short |
| Butyl Rubber water tank (5000 gallons) | Cost (1900 shs) high but very low depreciation rate expected | Is filled in normal rainy season by house and kitchen roofs |
| Stall-feeding yard | Big problem of poaching in wet weather | Experimenting with small concrete area. 1 local farmer adopting |
| Guatemala Grass | More palatable and persistent than elephant grass | Large quantities of planting material sold locally |

RESEARCH RESULTS

See published papers: Hall (1969) Paper Number 75
Watts (1970) Paper Number 104
Webster (1971) Paper Number 111

## GENERAL COMMENTS

The small-holding project is slowly becoming an accepted part of the Kabanyolo scene. It is particularly useful for showing visitors the applicability of some of the work on the main farm. Interest amongst local farmers is increasing and one has recently started a stall-feeding unit.

Progress with the project has been delayed by the fact that there was no Farm Management Lecturer for many months during 1969 and 1970. Dr. Webster has now completed (R.D.R. 111) a major review of the experience on Small-holding Number 1. An undergraduate and a visiting postgraduate have undertaken studies concerned with Small-holding Number 3.

Major problems which remain to be tackled are:

a) Management of a stall-feeding unit particularly in relation to breeding performance

b) Investigation of ways of reducing the capital cost of dairy small-holdings

c) Problems of acidity and water control in the swamp areas

d) Monkey control measures for passion fruit

e) Creation of greater interest in the project by Government and Uganda Commercial Bank Circles

f) Experimentation with ways of operating a small-holding primarily for extension purposes (see Luteete Report)

## REVISED BUDGET 1971-1972

| | Uganda Shillings | | |
|---|---|---|---|
| | Stipends | Travel | Loan Fun/ Supplies |
| Supervisor of Teso/Bukedi Small-holdings | 5,000 | 3,000 | -- |
| Proposed new small-holding in Teso/Bukedi | 2,400 | 500 | 15,000 |

Revised Budget (Continued)

| | Stipends | Travel | Loan Fund/ Supplies |
|---|---|---|---|
| Maintenance of Numbers 1 and 2 | 1,200 | 900 | 1,000 |
| Completion of Number 3 | 2,400 | 900 | 3,000 |
| Proposed poultry/pig small-holdings | 4,800 | 900 | 20,000 |
| Development of Luteete/ Nwanamugimu for extension purposes | 6,000 | 1,000 | 2,000 |
| (See separate report) | | | |
| | 21,800 | 7,200 | 41,000 |

Total = 70,000 Shs.

## Appendix C

## PROGRESS REPORT
## CONTRACT USAID/afr-411

OKRA J. ABBOTT
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

### A.S.2

### TITLE

Comparisons of Strains of Chickens for Production and Marketability of Eggs in Uganda

Three flocks of laying chickens whose growth and early egg production were described in Research Progress Report A.S.2, October, 1969, have been carried through another year of egg production from July 29, 1969 to July 27, 1970. The age of the layers covered in this report begins at 55 weeks and continues through 106 weeks.

These chickens are Sykes hybrid layers H-7, H-3 and Nick-Chick obtained as day-old chicks from their hatcheries in England. They have an average mature body weight of approximately 5.5, 5.0 and 4.0 pounds respectively. They were chosen to represent large, medium and small size hens in order to demonstrate in Uganda how smaller hens require less feed to produce eggs than large type hens.

Table 1 shows egg production for the three flocks from the 55th through the 106th week of age. The medium size layers, H-3, continued to produce eggs at the highest rate essentially throughout the period under study as they had done in the initial period of production described in the Report noted above. This is shown in the average percentages of egg production which were 47.2, 56.0 and 51.4 for the large, medium and small size layers. In general, the smaller, Leghorn-type later would be expected to lay eggs at a higher rate than occurred in the Nick-Chick flock.

Feed consumption to egg production ratios are shown in Table 2. Less feed was required to produce eggs in both flocks of the smaller layers even though the Nick-Chicks did not lay at the rate expected. Average grams of feed per egg produced ratios were 221.4, 190.9 and 195.9 in the large H-7, medium H-3 and small size Nick-Chick layers. This is an important saving in the cost of producing eggs since feed costs may amount to as much as 75 percent of total costs of production in tropical areas.

Egg shell quality as indicated by cracked shells occurring in the routine handling of eggs is shown in Table 3. The Nick-Chick layers had the poorest shells with an average 6.0 percent cracked, whereas the H-7 layers had the strongest shells with only 3.2 percent cracked. An intermediate 4.5 percent occurred in the medium sized H-3 layers. None of these percentages really is excessive if the age of the hens is considered. However, the shells from the Nick-Chick layers in this instance were not quite as strong as would be desired.

Mortality (Table 4) was not excessive reaching only 14.5, 12.6 and 13.8 in H-7, H-3 and Nick-Chick flocks. These reasonable figures indicate the generally healthy conditions that prevailed. It was the persisting healthy condition of the birds that seemed to impress most favourably the students in the Faculty of Agriculture and others who continued to observe and show an interest in the flocks.

The performance of the flocks generally was good. Even so, production rates never were quite as high by as much as 5-10 percent as might be expected in temperate zones of the world. This may have been caused simply by the short, approximately 12-hour day length occurring throughout the year in equatorial latitudes. Hens have a photochemical response in their egg production capacities. Out Poultry Unit did not have facilities available for lighting the birds a few extra hours per day, but these facilities are being installed for use on future flocks.

A summary of expenses and returns for these flocks is given in Table 5. Total expenses were Shs. 14,691.86 and returns were 26,599.10 giving a welcomed profit of 11,867.24. This was obtained with something less than 600 laying hens.

Table 1. Egg Production

| Age | H 7 | | | H3 | | | HNC | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Layers | Number Eggs/ Week | Percent Production | Number Layers | Number Eggs/ Week | Percent Production | Number Layers | Number Eggs/ Week | Percent Production |
| 55 | 187 | 846 | 64.6 | 197 | 1,074 | 77.9 | 193 | 955 | 70.7 |
| 56 | 187 | 868 | 66.3 | 197 | 1,029 | 74.6 | 193 | 949 | 70.2 |
| 57 | 186 | 824 | 63.3 | 197 | 986 | 71.5 | 192 | 924 | 68.8 |
| 58 | 186 | 818 | 62.8 | 197 | 1,009 | 73.2 | 192 | 903 | 67.2 |
| 59 | 185 | 833 | 64.3 | 196 | 1,002 | 72.7 | 191 | 919 | 68.7 |
| 60 | 185 | 797 | 61.5 | 196 | 977 | 70.8 | 191 | 898 | 67.2 |
| 61 | 185 | 779 | 60.2 | 196 | 948 | 68.7 | 191 | 869 | 65.0 |
| 62 | 185 | 759 | 58.6 | 196 | 945 | 68.9 | 191 | 843 | 63.1 |
| 63 | 185 | 764 | 59.0 | 195 | 957 | 70.1 | 190 | 857 | 64.4 |
| 64 | 185 | 754 | 58.2 | 195 | 931 | 68.2 | 189 | 832 | 62.9 |
| 65 | 185 | 746 | 57.6 | 195 | 914 | 67.0 | 189 | 811 | 61.3 |
| 66 | 185 | 697 | 53.8 | 195 | 900 | 65.9 | 189 | 807 | 61.0 |
| 67 | 185 | 660 | 51.0 | 195 | 896 | 65.6 | 189 | 791 | 59.8 |
| 68 | 185 | 603 | 46.6 | 195 | 873 | 64.0 | 189 | 768 | 58.0 |
| 69 | 185 | 622 | 48.0 | 195 | 873 | 64.0 | 189 | 751 | 56.8 |
| 70 | 185 | 626 | 48.3 | 195 | 860 | 63.0 | 189 | 735 | 55.6 |
| 71 | 185 | 640 | 49.4 | 194 | 864 | 63.6 | 189 | 736 | 55.6 |
| 72 | 185 | 599 | 46.3 | 194 | 871 | 64.1 | 189 | 674 | 50.9 |
| 73 | 185 | 650 | 50.2 | 194 | 853 | 62.8 | 189 | 678 | 51.2 |
| 74 | 173 | 625 | 51.6 | 182 | 826 | 64.8 | 181 | 676 | 53.4 |
| 75 | 141 | 603 | 61.1 | 161 | 801 | 71.1 | 148 | 662 | 63.9 |
| 76 | 141 | 548 | 55.5 | 161 | 705 | 62.6 | 148 | 603 | 58.2 |
| 77 | 141 | 551 | 55.8 | 161 | 714 | 63.4 | 148 | 576 | 55.6 |
| 78 | 141 | 487 | 49.3 | 161 | 682 | 60.5 | 148 | 553 | 53.4 |
| 79 | 141 | 463 | 46.9 | 161 | 643 | 57.1 | 148 | 517 | 49.9 |
| 80 | 141 | 432 | 43.8 | 161 | 664 | 58.9 | 148 | 490 | 47.3 |
| 81 | 141 | 450 | 45.6 | 161 | 659 | 58.5 | 148 | 514 | 49.6 |
| 82 | 141 | 455 | 46.1 | 161 | 651 | 57.8 | 148 | 536 | 51.7 |
| 83 | 141 | 418 | 42.4 | 161 | 616 | 54.7 | 148 | 506 | 48.8 |
| 84 | 141 | 410 | 41.5 | 161 | 625 | 55.5 | 148 | 488 | 47.1 |
| 85 | 141 | 394 | 39.9 | 161 | 570 | 50.6 | 148 | 494 | 47.7 |
| 86 | 139 | 411 | 42.2 | 159 | 521 | 46.8 | 148 | 463 | 44.7 |
| 87 | 139 | 389 | 40.0 | 159 | 515 | 46.3 | 148 | 448 | 43.2 |
| 88 | 139 | 397 | 40.8 | 158 | 539 | 48.7 | 147 | 463 | 45.0 |
| 89 | 139 | 410 | 42.1 | 158 | 523 | 47.3 | 147 | 448 | 43.5 |
| 90 | 139 | 424 | 43.6 | 158 | 510 | 46.1 | 147 | 455 | 44.2 |

Table 1. Egg Production (Continued)

| Age | H 7 | | | H 3 | | | H N C | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Layers | Number Eggs/ Week | Percent Production | Number Layers | Number Eggs/ Week | Percent Production | Number Layers | Number Eggs/ Week | Percent Production |
| 91 | 139 | 407 | 41.8 | 158 | 513 | 46.4 | 146 | 441 | 43.2 |
| 92 | 139 | 401 | 41.2 | 158 | 502 | 45.4 | 146 | 441 | 43.2 |
| 93 | 139 | 376 | 38.6 | 158 | 539 | 48.7 | 146 | 444 | 43.4 |
| 94 | 139 | 375 | 38.5 | 158 | 509 | 46.0 | 146 | 439 | 43.0 |
| 95 | 138 | 375 | 38.8 | 157 | 497 | 45.2 | 146 | 448 | 43.8 |
| 96 | 138 | 390 | 40.4 | 155 | 487 | 44.9 | 145 | 448 | 44.1 |
| 97 | 138 | 386 | 40.0 | 155 | 486 | 44.8 | 145 | 422 | 41.6 |
| 98 | 138 | 395 | 40.9 | 154 | 458 | 42.5 | 144 | 428 | 42.5 |
| 99 | 138 | 372 | 38.5 | 153 | 400 | 37.3 | 143 | 393 | 39.3 |
| 100 | 138 | 353 | 36.5 | 153 | 403 | 37.6 | 143 | 405 | 40.5 |
| 101 | 136 | 323 | 33.9 | 153 | 422 | 39.4 | 143 | 373 | 37.3 |
| 102 | 136 | 327 | 34.3 | 153 | 421 | 39.3 | 143 | 400 | 40.0 |
| 103 | 136 | 339 | 35.6 | 152 | 419 | 39.4 | 142 | 382 | 38.4 |
| 104 | 136 | 307 | 32.2 | 151 | 393 | 37.2 | 139 | 357 | 36.7 |
| 105 | 134 | 305 | 32.5 | 151 | 388 | 36.7 | 139 | 332 | 34.1 |
| 106 | 133 | 306 | 32.9 | 150 | 363 | 34.6 | 137 | 336 | 35.0 |
| Total Eggs: | | 27,489 | | | 35,726 | | | 31,081 | |
| Av. Percent Production: | | | 47.2 | | | 56.0 | | | 51.4 |

Table 2. Feed Consumption/Egg Production Ratios

| Age | H 7 | | | H 3 | | | H N C | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Kg Feed | Number Eggs | Gm Feed Per Egg | Kg Feed | Number Eggs | Gm Feed Per Egg | Kg Feed | Number Eggs | Gm Feed Per Egg |
| 55 | 152.7 | 846 | 180.5 | 160.4 | 1,074 | 149.5 | 151.1 | 955 | 158.2 |
| 56 | 151.4 | 868 | 174.4 | 160.3 | 1,029 | 155.8 | 148.5 | 949 | 156.5 |
| 57 | 146.4 | 824 | 177.7 | 158.3 | 986 | 160.5 | 144.6 | 924 | 156.5 |
| 58 | 143.8 | 818 | 176.8 | 157.0 | 1,009 | 155.6 | 147.2 | 903 | 163.0 |
| 59 | 147.1 | 833 | 176.6 | 156.5 | 1,002 | 156.2 | 155.8 | 919 | 169.5 |
| 60 | 141.4 | 797 | 177.4 | 153.3 | 977 | 156.9 | 142.5 | 898 | 158.7 |
| 61 | 146.0 | 779 | 187.4 | 158.8 | 948 | 167.5 | 141.9 | 869 | 163.3 |
| 62 | 146.3 | 759 | 192.7 | 158.7 | 945 | 167.9 | 144.5 | 843 | 171.4 |
| 63 | 147.9 | 764 | 193.6 | 159.6 | 957 | 166.8 | 148.7 | 857 | 173.5 |
| 64 | 142.5 | 754 | 189.0 | 155.5 | 931 | 167.0 | 140.9 | 832 | 169.4 |
| 65 | 135.0 | 746 | 181.0 | 153.4 | 914 | 167.8 | 137.8 | 811 | 169.9 |
| 66 | 132.9 | 697 | 190.7 | 155.8 | 900 | 173.1 | 144.7 | 807 | 179.3 |
| 67 | 131.8 | 660 | 199.7 | 154.1 | 896 | 172.0 | 143.6 | 791 | 181.4 |
| 68 | 132.6 | 603 | 219.9 | 152.3 | 873 | 174.4 | 138.6 | 768 | 180.5 |
| 69 | 132.2 | 622 | 212.5 | 147.8 | 873 | 169.3 | 136.4 | 751 | 181.6 |
| 70 | 135.5 | 626 | 216.4 | 150.0 | 860 | 174.4 | 139.7 | 735 | 190.1 |
| 71 | 139.4 | 640 | 217.8 | 155.0 | 864 | 179.4 | 139.4 | 736 | 189.4 |
| 72 | 152.6 | 599 | 254.4 | 140.9 | 871 | 161.8 | 137.1 | 674 | 203.4 |
| 73 | 138.7 | 650 | 213.4 | 151.8 | 853 | 178.0 | 136.6 | 678 | 201.5 |
| 74 | 130.5 | 625 | 208.8 | 140.1 | 826 | 169.6 | 129.3 | 676 | 191.3 |
| 75 | 122.9 | 603 | 203.8 | 132.9 | 801 | 165.9 | 116.1 | 662 | 175.4 |
| 76 | 111.6 | 548 | 203.6 | 130.4 | 705 | 185.0 | 113.3 | 603 | 188.0 |
| 77 | 131.8 | 551 | 239.2 | 125.0 | 714 | 175.0 | 101.1 | 576 | 175.5 |
| 78 | 121.2 | 487 | 248.9 | 129.7 | 682 | 190.2 | 113.9 | 553 | 206.0 |
| 79 | 103.1 | 463 | 222.7 | 131.5 | 643 | 204.5 | 121.4 | 517 | 219.5 |
| 80 | 105.5 | 432 | 244.2 | 133.0 | 664 | 200.3 | 109.0 | 490 | 222.4 |
| 81 | 102.2 | 450 | 227.1 | 126.6 | 659 | 192.1 | 108.9 | 514 | 211.9 |
| 82 | 100.7 | 455 | 221.3 | 123.0 | 651 | 188.9 | 102.5 | 536 | 191.2 |
| 83 | 98.4 | 418 | 235.4 | 121.0 | 616 | 196.4 | 101.8 | 506 | 201.2 |
| 84 | 105.9 | 510 | 258.3 | 123.9 | 625 | 198.2 | 110.5 | 488 | 226.4 |
| 85 | 101.0 | 394 | 256.3 | 122.0 | 570 | 214.0 | 104.2 | 494 | 210.9 |
| 86 | 94.1 | 411 | 228.9 | 110.8 | 521 | 212.7 | 97.3 | 463 | 210.1 |
| 87 | 102.0 | 389 | 262.2 | 118.8 | 515 | 230.7 | 103.4 | 448 | 230.8 |
| 88 | 115.9 | 397 | 291.9 | 119.7 | 539 | 222.3 | 107.1 | 463 | 231.3 |
| 89 | 126.5 | 410 | 308.5 | 143.5 | 523 | 274.4 | 126.5 | 448 | 282.4 |
| 90 | 118.0 | 424 | 278.3 | 108.0 | 510 | 211.8 | 101.0 | 455 | 222.0 |
| 91 | 98.3 | 407 | 241.5 | 116.9 | 513 | 227.9 | 97.1 | 441 | 220.2 |
| 92 | 97.6 | 401 | 243.4 | 118.3 | 502 | 235.6 | 99.7 | 441 | 226.1 |
| 93 | 95.9 | 376 | 255.0 | 119.0 | 539 | 220.8 | 102.6 | 444 | 231.1 |

Table 2. Feed Consumption/Egg Production Ratios (Continued)

| Age | H 7 | | | H 3 | | | H N C | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Kg Feed | Number Eggs | Gm Feed Per Egg | Kg Feed | Number Eggs | Gm Feed Per Egg | Kg Feed | Number Eggs | Gm Feed Per Egg |
| 94 | 119.5 | 375 | 318.7 | 138.9 | 509 | 272.9 | 120.0 | 439 | 273.3 |
| 95 | 95.7 | 375 | 255.2 | 112.6 | 497 | 226.5 | 96.6 | 448 | 215.6 |
| 96 | 94.2 | 390 | 241.5 | 112.1 | 487 | 230.2 | 91.1 | 448 | 203.3 |
| 97 | 99.8 | 386 | 258.5 | 112.3 | 486 | 231.1 | 94.6 | 422 | 224.2 |
| 98 | 89.1 | 395 | 225.6 | 108.9 | 458 | 237.8 | 91.8 | 428 | 214.5 |
| 99 | 77.8 | 372 | 209.1 | 93.1 | 400 | 232.7 | 83.2 | 393 | 211.7 |
| 100 | 72.4 | 353 | 205.0 | 91.7 | 403 | 227.5 | 75.2 | 405 | 185.7 |
| 101 | 96.4 | 323 | 298.4 | 114.6 | 422 | 271.6 | 99.9 | 373 | 267.8 |
| 102 | 95.6 | 327 | 292.3 | 91.6 | 421 | 217.6 | 94.4 | 400 | 236.0 |
| 103 | 90.2 | 339 | 266.1 | 103.7 | 419 | 247.5 | 90.7 | 382 | 237.4 |
| 104 | 90.3 | 307 | 294.1 | 99.8 | 393 | 253.9 | 87.7 | 357 | 245.6 |
| 105 | 95.5 | 305 | 313.1 | 105.4 | 388 | 271.6 | 92.2 | 332 | 277.7 |
| 106 | 89.7 | 306 | 293.1 | 100.6 | 363 | 277.1 | 86.5 | 336 | 257.4 |
| | 6,085.5 | 27,489 | 221.4 | 6,819.0 | 35,726 | 190.9 | 6,090.2 | 31,081 | 195.9 |

Table 3. Egg Shell Quality (Percent Cracked Shells)

| Age | H 7 | | | H 3 | | | H N C | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Eggs | Number Cracked | Percent Cracked | Number Eggs | Number Cracked | Percent Cracked | Number Eggs | Number Cracked | Percent Cracked |
| 55 | 846 | 20 | 2.4 | 1,074 | 41 | 3.8 | 955 | 39 | 4.1 |
| 56 | 868 | 27 | 3.1 | 1,029 | 47 | 4.6 | 949 | 50 | 5.3 |
| 57 | 824 | 20 | 2.4 | 986 | 19 | 1.9 | 924 | 57 | 6.2 |
| 58 | 818 | 11 | 1.3 | 1,009 | 25 | 2.5 | 903 | 25 | 2.8 |
| 59 | 833 | 15 | 1.8 | 1,002 | 22 | 2.2 | 919 | 35 | 3.8 |
| 60 | 797 | 32 | 4.0 | 977 | 56 | 5.7 | 898 | 76 | 8.5 |
| 61 | 779 | 19 | 2.4 | 948 | 44 | 4.6 | 869 | 29 | 3.3 |
| 62 | 759 | 25 | 3.3 | 945 | 41 | 4.3 | 843 | 40 | 4.7 |
| 63 | 764 | 19 | 2.5 | 957 | 37 | 3.9 | 857 | 29 | 3.4 |
| 64 | 754 | 21 | 2.8 | 931 | 42 | 4.5 | 832 | 51 | 6.1 |
| 65 | 746 | 20 | 2.7 | 914 | 45 | 4.9 | 811 | 42 | 5.2 |
| 66 | 697 | 10 | 1.4 | 900 | 26 | 2.9 | 807 | 26 | 3.2 |
| 67 | 660 | 16 | 2.4 | 896 | 23 | 2.6 | 791 | 40 | 5.1 |
| 68q | 603 | 15 | 2.5 | 873 | 28 | 3.2 | 768 | 55 | 7.2 |
| 69 | 622 | 16 | 2.6 | 873 | 40 | 4.6 | 751 | 57 | 7.6 |
| 70 | 626 | 22 | 3.5 | 860 | 33 | 3.8 | 735 | 38 | 5.2 |
| 71 | 640 | 21 | 3.3 | 864 | 38 | 4.4 | 736 | 48 | 6.5 |
| 72 | 599 | 21 | 3.5 | 871 | 30 | 3.4 | 674 | 28 | 4.2 |
| 73 | 650 | 14 | 2.2 | 853 | 39 | 4.6 | 678 | 41 | 6.0 |
| 74 | 625 | 26 | 4.2 | 826 | 35 | 4.2 | 676 | 28 | 4.1 |
| 75 | 603 | 20 | 3.3 | 801 | 49 | 6.1 | 662 | 35 | 5.3 |
| 76 | 548 | 20 | 3.6 | 705 | 40 | 5.7 | 603 | 41 | 6.8 |
| 77 | 551 | 17 | 3.1 | 714 | 23 | 3.2 | 576 | 42 | 7.3 |
| 78 | 487 | 43 | 8.8 | 682 | 35 | 5.1 | 553 | 34 | 6.1 |
| 79 | 463 | 19 | 4.1 | 643 | 27 | 4.2 | 517 | 43 | 8.3 |
| 80 | 432 | 5 | 1.2 | 664 | 28 | 4.2 | 490 | 29 | 5.9 |
| 81 | 450 | 12 | 2.7 | 659 | 53 | 8.0 | 514 | 26 | 5.1 |
| 82 | 455 | 10 | 2.2 | 651 | 41 | 6.3 | 536 | 31 | 5.8 |
| 83 | 418 | 19 | 4.5 | 616 | 26 | 4.2 | 506 | 37 | 7.3 |
| 84 | 410 | 13 | 3.2 | 625 | 27 | 4.3 | 488 | 34 | 7.0 |
| 85 | 394 | 8 | 2.0 | 570 | 31 | 5.4 | 494 | 28 | 5.7 |
| 86 | 411 | 23 | 5.6 | 521 | 35 | 6.7 | 463 | 41 | 8.9 |
| 87 | 389 | 9 | 2.3 | 515 | 21 | 4.1 | 448 | 25 | 5.6 |
| 88 | 397 | 14 | 3.5 | 539 | 33 | 6.1 | 463 | 35 | 7.6 |
| 89 | 410 | 10 | 2.4 | 523 | 23 | 4.4 | 448 | 27 | 6.0 |
| 90 | 424 | 12 | 2.8 | 510 | 35 | 6.9 | 455 | 30 | 6.6 |
| 91 | 407 | 5 | 1.2 | 513 | 30 | 5.8 | 441 | 27 | 6.1 |
| 92 | 401 | 8 | 2.0 | 502 | 15 | 3.0 | 441 | 21 | 4.8 |
| 93 | 376 | 8 | 2.1 | 539 | 20 | 3.7 | 444 | 25 | 5.6 |

Table 3. Egg Shell Quality (Percent Cracked Shells) (Continued)

| Age | H 7 | | | H 3 | | | H N C | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Eggs | Number Cracked | Percent Cracked | Number Eggs | Number Cracked | Percent Cracked | Number Eggs | Number Cracked | Percent Cracked |
| 94 | 375 | 8 | 2.1 | 509 | 23 | 4.5 | 439 | 26 | 5.9 |
| 95 | 375 | 8 | 2.1 | 497 | 24 | 4.8 | 448 | 23 | 5.1 |
| 96 | 390 | 11 | 2.8 | 487 | 25 | 5.1 | 448 | 32 | 7.1 |
| 97 | 386 | 15 | 3.9 | 486 | 30 | 6.2 | 422 | 32 | 7.6 |
| 98 | 395 | 23 | 5.8 | 458 | 34 | 7.4 | 428 | 34 | 7.9 |
| 99 | 372 | 25 | 9.2 | 400 | 24 | 6.0 | 393 | 42 | 10.7 |
| 100 | 353 | 15 | 4.2 | 403 | 25 | 6.2 | 405 | 45 | 11.1 |
| 101 | 323 | 16 | 5.0 | 422 | 26 | 6.2 | 373 | 23 | 6.2 |
| 102 | 327 | 12 | 3.7 | 421 | 20 | 4.8 | 400 | 36 | 9.0 |
| 103 | 339 | 22 | 6.5 | 419 | 17 | 4.1 | 382 | 31 | 8.1 |
| 104 | 307 | 14 | 4.6 | 393 | 23 | 5.9 | 357 | 27 | 7.6 |
| 105 | 305 | 11 | 3.6 | 388 | 19 | 4.9 | 332 | 31 | 9.3 |
| 106 | 306 | 21 | 6.9 | 363 | 28 | 7.7 | 336 | 26 | 7.7 |
| Total Eggs | 27,489 | | | 35,726 | | | 31,081 | | |
| Total Cracked | | 866 | | | 1,621 | | | 1,853 | |
| Average Percent Cracked | | | 3.2 | | | 4.5 | | | 6.0 |

Table 4. Mortality

| Age | H 7 (207 Day-Old Chicks) | | | H 3 (207 Day-Old Chicks) | | | H N C (210 Day-Old Chicks) | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Died | Total Dead | Total Percent Mortality | Number Died | Total Dead | Total Percent Mortality | Number Died | Total Dead | Total Percent Mortality |
| 55 | 0 | 20 | 9.7 | 0 | 10 | 4.8 | 0 | 14 | 6.8 |
| 56 | 0 | 20 | 9.7 | 0 | 10 | 4.8 | 0 | 14 | 6.8 |
| 57 | 1 | 21 | 10.1 | 0 | 10 | 4.8 | 1 | 15 | 7.1 |
| 58 | 0 | 21 | 10.1 | 0 | 10 | 4.8 | 0 | 15 | 7.1 |
| 59 | 1 | 22 | 10.6 | 0 | 10 | 4.8 | 1 | 16 | 7.6 |
| 60 | 0 | 22 | 10.6 | 0 | 10 | 4.8 | 0 | 16 | 7.6 |
| 61 | 0 | 22 | 10.6 | 0 | 10 | 4.8 | 0 | 16 | 7.6 |
| 62 | 0 | 22 | 10.6 | 1 | 11 | 5.3 | 0 | 16 | 7.6 |
| 63 | 0 | 22 | 10.6 | 1 | 12 | 5.8 | 1 | 17 | 8.1 |
| 64 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 1 | 18 | 8.6 |
| 65 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 66 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 67 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 68 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 69 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 70 | 0 | 22 | 10.6 | 0 | 12 | 5.8 | 0 | 18 | 8.6 |
| 71 | 0 | 22 | 10.6 | 1 | 13 | 6.3 | 0 | 18 | 8.6 |
| 72 | 0 | 22 | 10.6 | 0 | 13 | 6.3 | 0 | 18 | 8.6 |
| 73 | 0 | 22 | 10.6 | 0 | 13 | 6.3 | 0 | 18 | 8.6 |
| 74 | 0 | 22 | 10.6 | 0 | 13 | 6.3 | 0 | 18 | 8.6 |
| 75 | 0 | 22 | 10.6 | 2 | 15 | 7.2 | 0 | 18 | 8.6 |
| 76 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 77 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 78 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 79 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 80 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 81 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 82 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 83 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 84 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 85 | 0 | 22 | 10.6 | 0 | 15 | 7.2 | 0 | 18 | 8.6 |
| 86 | 0 | 24 | 11.6 | 2 | 17 | 8.2 | 0 | 18 | 8.6 |
| 87 | 0 | 24 | 11.6 | 0 | 17 | 8.2 | 0 | 18 | 8.6 |
| 88 | 0 | 24 | 11.6 | 1 | 18 | 8.7 | 1 | 19 | 9.0 |
| 89 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 0 | 19 | 9.0 |
| 90 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 0 | 19 | 9.0 |

Table 4. Mortality (Continued)

| Age | H 7<br>(207 Day-Old Chicks) | | | H 3<br>(207 Day-Old Chicks) | | | H N C<br>(210 Day-Old Chicks) | | |
|---|---|---|---|---|---|---|---|---|---|
| Weeks | Number Died | Total Dead | Total Percent Mortality | Number Died | Total Dead | Total Percent Mortality | Number Died | Total Dead | Total Percent Mortality |
| 91 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 1 | 20 | 9.5 |
| 92 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 0 | 20 | 9.5 |
| 93 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 0 | 20 | 9.5 |
| 94 | 0 | 24 | 11.6 | 0 | 18 | 8.7 | 0 | 20 | 9.5 |
| 95 | 1 | 25 | 12.1 | 1 | 19 | 9.2 | 0 | 20 | 9.5 |
| 96 | 0 | 25 | 12.1 | 2 | 21 | 10.1 | 1 | 21 | 10.0 |
| 97 | 0 | 25 | 12.1 | 0 | 21 | 10.1 | 0 | 21 | 10.0 |
| 98 | 0 | 25 | 12.1 | 1 | 22 | 10.6 | 1 | 22 | 10.5 |
| 99 | 0 | 25 | 12.1 | 1 | 23 | 11.1 | 1 | 23 | 11.0 |
| 100 | 0 | 25 | 12.1 | 0 | 23 | 11.1 | 0 | 23 | 11.0 |
| 101 | 2 | 27 | 13.0 | 0 | 23 | 11.1 | 0 | 23 | 11.0 |
| 102 | 0 | 27 | 13.0 | 0 | 23 | 11.1 | 0 | 23 | 11.0 |
| 103 | 0 | 27 | 13.0 | 1 | 24 | 11.6 | 1 | 24 | 11.4 |
| 104 | 0 | 27 | 13.0 | 1 | 25 | 12.1 | 3 | 27 | 12.9 |
| 105 | 2 | 29 | 14.0 | 0 | 25 | 12.1 | 0 | 27 | 12.9 |
| 106 | 1 | 30 | 14.5 | 1 | 26 | 12.6 | 2 | 29 | 13.8 |

Table 5. Expense and Income

| Item | Expenses | Income | Balance |
|---|---|---|---|
| 1. Laying Mash | | | |
| (19,040 kg at Shs.0.61) | 11,614.40 | | |
| 2. Oyster Shell | | | |
| (454 kg at Shs.0.99) | 449.46 | | |
| 3. Labor: | | | |
| 1 man equivalent | | | |
| 12 months at Shs.219.00) | 2,628.00 | | |
| Total: | 14,691.86 | | |
| 4. Eggs Sold | | | |
| 66,664 Large at Shs.0.30 | | 19,999.20 | |
| 21,040 Medium at Shs.0.25 | | 5,260.00 | |
| 3,659 Cracked-Spots at Shs.0.10 | | 365.90 | |
| | | 25,625.10 | |
| 5. Culled Hens Sold | | | |
| 44 Large (H-7) at Shs.10.00 | | 440.00 | |
| 31 Medium (H-3) at Shs.8.00 | | 248.00 | |
| 41 Small (H-NC) at Shs.6.00 | | 246.00 | |
| | | 934.00 | |
| Total: | | 26,559.10 | |
| 6. Balance | | | Shs.11,867.24 |

## Appendix D

## PROGRESS REPORT
## CONTRACT USAID/afr-411

DEAN L. MCILROY
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

### A.S.8

### TITLE

A Study of Feeding and Management Factors Which Influence Milk Production and Reproduction in Exotic Dairy Cattle in Uganda

Dr. McIlroy's dairy experiment is still in progress. An analysis of the milk production data from the first 112 days of lactation showed that an overall increase of 40.7 percent had occurred in this lactation compared to the same period in the previous lactation (Table 1). An average increase of 36.2 percent and 42.8 percent has been recorded for the pasture and silage treatments, respectively.

An unexpected increase of 33.4 percent in milk production over the previous lactation occurred in the control treatment. This treatment consisted of the regular feeding program used at the Kabanyolo dairy (pasture plus regular concentrate program). One would assume there would be only a small change in the control treatment due to difference in lactation number and season of year the cows freshened. After studying the feeding program thoroughly, it appears that the cows on the regular dairy feeding program were fed 37.6 percent more concentrate than the rules of the farm dairy concentrate program called for (Table 2). One cow actually received 58.6 percent extra concentrate while the second cow was fed only 16.6 percent extra concentrate. This arbitrary increase (due to the failure of the farm staff to follow the regular program) averaged 37.6 percent extra concentrate consumed. The 33.4 percent increase in milk yield over the previous lactation is conceivably due to a feeding program that more closely matches or approximates the energy needs of the lactating dairy cows.

Examination of the other treatments reveals a large amount of variation between cows. We must await the end of a change-over designed experiment intended to remove this biological variation. It will be completed in mid-April.

Table 1. Milk Production in the First 112 Days of the Present and Previous Lactations of the 10 Experimental Cows.

| Treatment | Milk Produced | | Milk Produced | | Average Percent Increase |
|---|---|---|---|---|---|
| | Kg | Percent Increase | Kg | Percent Increase | |
| Pasture plus regular concentrate | OBEL<br>2294.41[a]<br>1758.60[b] | 30.46 | LUMUMBA<br>1870.05<br>1372.42 | 36.25 | 33.36 |
| Pasture plus high concentrate program | BONY<br>2442.19<br>2115.39 | 15.44 | ROBERT<br>1559.18<br>958.23 | 62.71 | 39.08 |
| Silage plus regular concentrate program | LYDIA<br>1879.77<br>1384.48[c] | 35.77 | ELGON<br>1531.48<br>802.14 | 90.92 | 63.34 |
| Silage plus high concentrate program | INDIA<br>1294.16<br>1102.44 | 17.39 | RUSSIA<br>1749.51<br>1377.90 | 26.97 | 22.18 |
| Silage plus high concentrate program plus cool treatment | WHITE STAR<br>2133.51<br>1308.95 | 62.99 | KATHERINE<br>1851.91<br>1446.47 | 27.94 | 45.46 |
| Average percent increase | | | | | 40.67 |

[a] Total Kg of fat corrected milk (FCM) produced during the first 112 days in the present lactation.

[b] Total Kg of FCM produced in the first 112 days of the previous lactation.

[c] $$X = \frac{rB + tT - G}{(r-1)\ (t-1)} = \frac{2(6885.38) + 5(802.14) - 12,243.53}{1 \times 4}$$

$$= \frac{5537.93}{4} = 1384.48$$

Table 2. Milk Production and Concentrate Consumption of the Two Cows on the Regular Farm Feeding Program During the First 112 Days of the Present and Previous Lactations.

| | Milk Produced | | Concentrate | |
|---|---|---|---|---|
| Name of Cow | Kg | Percent Increase | Kg | Percent Increase |
| Obel | 2294.41[a]<br>1758.60 | 30.46 | 1012[c]<br>868[d] | 16.59 |
| Lumumba | 1870.05<br>1372.42 | 36.25 | 1110<br>700 | 58.57 |
| Average percent increase | | 33.36 | | 37.58 |

[a] Total Kg of fat corrected milk (FCM) produced during the first 112 days in the present lactation.

[b] Total Kg of FCM produced in the first 112 days of the previous lactation.

[c] The Kg of concentrate fed in the first 112 days of the present lactation.

[d] The Kg of concentrate that should have been fed according to the rules of the regular farm program as outlined by the dairy husbandman.

Appendix E

# PROGRESS REPORT
CONTRACT USAID/afr-411

FARREL J. OLSEN AND PAUL G. MOE
FACULTY OF AGRICULTURE
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## C.S.5

## TITLE

The Effect of Phosphate and Lime on the Establishment, Productivity, Nodulation, and Persistence of *Desmodium intortum* *Medicago sativa* and *Stylosanthes gracilis*

It is a common practice in some agricultural regions of the world to include legumes with grasses in pasture mixtures to increase the quality and quantity of herbage produced and also to enhance soil fertility. Research work has been done assessing the improvements attributable to the inclusion of legumes in leys. Strange (1961) compared grasses in pure stands and grasses in mixtures with Kenya white clover and lucerne. He found that the application of phosphate fertilizer significantly increased dry matter production. When gypsum was added at the rate of 150 cwt. per acre per year in combination with phosphate, a highly significant increase in legume growth and a consequent marked superiority of yield from the mixed swards over grass in pure stands was obtained.

In some exploratory field experiments, Bumpus (1957) found that substantial nitrogen fixation occurred in legumes under field conditions in Kenya. A strong positive interaction between innoculated clover and phosphate treatments was observed. Jones and Evans (1961) reported that the application of phosphate at the rate of 40 pounds of $P_2O_5$ per acre on *Trifolium semipilosum* resulted in limited effects on it's productivity.

The effects of applied phosphate at rates up to 212 pounds per acre and gypsum at rates up to 350 pounds per acre on the productivity of lucerne and clover was evaluated by Poultney (1963). It was reported that gypsum and phosphate increased the productivity of both lucerne and clover. Frequent applications of phosphate on lucerne compared to single applications in the first year were found to be inferior.

The primary objective of this investigation was to determine the effect of phosphate and lime on the establishment, productivity, nodulation and persistence of three legumes.

## EXPERIMENTAL PROCEDURE

This study was conducted at Makerere Univeristy Farm, Kabanyolo. The upland soils of Kabanyolo are classified as latosols, or as ferrallitic soils. These are deep, highly weathered and leached, fine textured, well-drained red soils. Before initiating the experiment, a soil sample was obtained from the experimental site. The soil analyses showed that the pH of the soil was 5.5, $P_2O_5$ level very low (8 ppm $P_2O_5$ Truog) and the available $K_2O$ medium (48 mg/100 g). The organic matter content was 3.1 percent. The experimental site had been in field crops for a number of years.

The climate at Kabanyolo is classified as moist tropical. Mean maximum temperatures vary from 28.5°C in January to 26.0°C in July, minimum temperatures from 17.4°C in April to 15.9°C in July and August. Annual rainfall is about 1300 mm with two peaks in April and November and two lows in January and July when mean monthly falls are about 60 mm.

A split-split-plot experimental design with five replications was employed to study the responses of *Desmodium intortum*, *Medicago sativa*, and *Stylosanthes gracilis* to the various rates of application of lime and phosphate. The main plots were legumes. The split-plots consisted of the lime treatments. The split-split-plots were phosphate treatments. The plots were 6.4 m x 18.3 m.

The lime rates were 0, 2.5, 5 and 10 metric tons/hectare. The phosphate rates were 0, 112, 224, and 448 kilograms of $P_2O_5$/hectare. The treatments were applied in all combinations making a total of 16 different treatments. Single superphosphate was used as the $P_2O_5$ source. Local agricultural limestone (88 percent $CaCO_3$) was utilized. Over 74 percent of the lime passed through a .50 mm sieve.

During October, 1967, a fine seedbed was prepared in the experimental area. Before seeding, muriate of potash at the rate of 112 kilograms $K_2O$/hectare was incorporated into the soil. Thereafter, the same rate of potassium fertilizer was used a a top-dressing at the beginning of each growing season. The prescribed amounts of limes and phosphate were applied by hand to each of the experimental plots. No subsequent applications of lime or phosphate were made. The materials were incorporated into the soil using a 'Landmaster' rotavator.

The legume seeds were innoculated with commerical innoculum imported from Australia prior to planting. A 'Planet Jr.' seeder was used to plant the legume seed at a depth of about 1 cm, spaced in rows 30 1/2 cm apart.

Harvesting was done when each legume reached the early flowering stage of growth. Prior to harvesting, a 0.9 m border strip was removed from the ends of the plots. A 0.9 m x 12.8 m strip was harvested from the middle of each plot to determine the dry matter production. Harvesting commenced in March, 1968, and continued for two years.

In May, 1969, root samples were obtained. Two plants, with the soil still intact around the roots, were dug from each of the experimental plots. They were placed individually in buckets of water to soak. After the soil was loosened from around the roots, the plants were taken from the buckets, top growth removed, and the roots placed in plastic bags for evaluation. Root samples were analyzed for nitrogen (N) and phosphorus (P) by standard analytical procedures. Nodulation was assessed by visual comparison of root samples. Samples were rated from 1 to 100 on the basis of size and number of nodules found on the roots.

A 1-2 kg sample of fresh herbage was taken from each of the experimental plots during the last harvest. These samples were separated by hand into their botanical components. Each of the component parts were weighed green, oven-dried and then reweighed. From this information, the botanical composition was determined for each of the legume species for each treatment.

At the conclusion of the study, soil samples were taken from each of the experimental plots and similar treatments from the five replications were composited. Analyses were made for pH, organic matter, P and Ca.

The data were analyzed statistically using Analysis of Variance. The significant differences among treatments were tested with Duncan's Multiple Range Tests.

## RESULTS

The use of phosphate fertilizer accelerated the establishment rate of the legumes. This was easily observed visually. It should be noted, however, that all the legumes were established successfully with all the different treatments imposed.

The effect of phosphate and lime on total dry matter production of the legumes for two years is presented in Table 1. The mean dry matter production for the three legumes ranged from 17,534 kg/ha for Medicago to 32,872 kg/ha for Desmodium. Both Desmodium and Stylosanthes yielded significantly more dry matter per hectare than Medicago. There was no significant difference in dry matter production between Desmodium and Stylosanthes. It is noteworthy that phosphate significantly increased dry matter production. Medicago tended to exhibit a response in dry matter production resulting from the use of lime. Neither Desmodium nor Stylosanthes responded to liming. No significant interactions were obtained. The total dry matter production of the legumes for each of the four harvest seasons is reported in Table 2.

Table 3 shows the effect of phosphate and lime on nodulation of the legume roots. There was no significant difference between Desmodium and Stylosanthes, but they both had a significantly higher nodulation rating than Medicago. Phosphate treatments resulted in increased nodulation of all three legumes. Lime tended to increase the nodulation of Medicago but had no effect on Desmodium or Stylosanthes.

The influence of phosphate and lime on the percentage legume in the stand after two years of harvesting is given in Table 4. Medicago had a significantly lower percentage of legume in the stand than the other two legumes. There were no real differences between Desmodium and Stylosanthes. Significant interactions occurred between legumes and phosphate. Medicago showed a strong response, Desmodium exhibited a slight response, and Stylosanthes demonstrated no response to phosphate application. Significant interactions also occurred between legumes and lime. Again Medicago showed a strong response, whereas, the other legumes showed little or no response.

The influence of phosphate and lime on the percentage of N in the legume roots was evaluated. This is reported in Table 5. Chemical analysis showed that Medicago had a significantly higher nitrogen percentage in the roots than the other legumes. There was no real difference in N content between Desmodium and Stylosanthes. Phosphate treatments increased the N percentages in the legume roots. Lime treatments, however, did not affect the N content of the roots significantly. A three way interaction among phosphorus, lime and legume was observed but it was only significant at the 5 percent level.

The effect of phosphate and lime on the percentages of P in legume roots is reported in Table 6. Medicago had a significantly higher percentage P than the other legumes. There were no apparent differences between Desmodium and Stylosanthes in P content of their roots. No real differences in P percentages in the legume roots resulted from using lime. A significant interaction was found between phosphate and legumes. The percentage P in the roots showed a significant response to the higher rates of phosphate application with Medicago and Desmodium, but not with Stylosanthes.

The analysis of soil samples taken at the conclusion of the study is found in Table 7. Although no statistical analyses were carried out, some general trends were evident. The use of agricultural lime generally resulted in enhanced Ca content of the soil and an increase in pH. The organic matter content was generally higher in soils which had Medicago and Desmodium. With increasing increments of phosphate fertilizer, the P content of the soils also generally increased.

## DISCUSSION

The highly weathered soils of the tropics are generally reputed to be low in available phosphate. This was true of the soil in this study. The short-term efficiency of phosphate fertilizers in these soils is very low. Unfortunately, much of the phosphate added as fertilizers is unavailable for plant growth. The application of high rates of phosphate fertilizer, therefore, was an attempt to partially satisfy the soil's phosphate fixation capacity.

Phosphate fertilizer had a beneficial effect on legume establishment in this study. With increasing increments of phosphate fertilizer, the rate of establishment was accelerated. Rapid establishment of tropical legumes is especially important during the short rains or when the legumes are planted late during the long rainy period of the year. Rapid establishment of legumes is also important in order for them to compete favorably with weeds. Band-seeding will assist in making better use of the fertilizer materials applied as starter fertilizers.

Phosphate fertilizers increased the dry matter production of the legumes. The results of this experiment, however, would indicate that there was no real advantage in applying more than 224 kg/ha of $P_2O_5$. Medicago was not as productive as Desmodium or Stylosanthes. Stylosanthes did not respond as much to increasing applications of phosphate as the other two legumes. This may substantiate the recommendation of the use of Stylosanthes on soils of low fertility. It was observed that Medicago did well during the long rains but during the short rains and during the dry seasons of the year it faltered in productivity. It is postulated, that under irrigation, it might prove to be a much better legume. The high levels of production of both *Desmodium* and *Stylosanthes* obtained in this experiment indicate that these legumes were well adapted to the soil and climate at Kabanyolo.

*Desmodium* and *Stylosanthes* maintained productive stands better than *Medicago*. The ability of *Desmodium* and *Stylosanthes* to 'creep' and fill in the gaps or bare patches of soil probably attributed to their good stands over the period of this study. It was quite evident from this study that in order to establish and maintain productive stands of *Desmodium* and *Medicago* the application of phosphate fertilizer is desirable on the type of soil used in this study.

Lime did not enhance the productivity of *Desmodium* or *Stylosanthes*. The site used in this study was moderately acid with a pH of about 5.5. Norris (1958) and Younge *et al* (1964) also reported little response from liming tropical legumes on moderately acid soils. However, they noted that the pH of the soils was raised. Slight responses by tropical legumes to lime have been reported by Landrau *et al* (1953). This may have been due to the temporary release of other plant nutrients by the lime and may not have represented a true yield response by the legume to the calcium.

Lime in great quantities on tropical soils could have a harmful effect on legume growth and development. On soils with a low exchange capacity, this could result in a 'crowding' of the exchange complex with calcium to the detriment of the other plant nutrients. Thus, there is a possibility of developing a deficiency of cations and trace elements through increased saturation with calcium or increased pH. Soil structure could also deteriorate as well as soil fertility through increased humus decomposition. *Medicago*, on the other hand, is best adapted to temperate conditions and is known to respond well to liming. The results of this study indicate that *Medicago* did respond to lime application as might be expected.

Nodulation was generally poor for all three legumes in this study. *Medicago*, however, was significantly poorer than the other two legumes. This would suggest that the rhizobium symbiant necessary for the nodulation of *Medicago* (*Rhizobium meliloti*) was unable to infect the roots effectively, possibly due to an incompatability of the organism with the local soil environment.

Nodulation of all three legumes was improved significantly with the application of phosphate. This was probably related to the general stimulation of root growth caused by the phosphate applications. Lime application increased the nodulation of *Medicago*, but had no effect on the other two legumes. This would lend further support to the theory that the soil environment was unsuitable for the rapid proliferation of

Rhizobium meliloti. With most legumes, nodule formation takes place in a narrower range of hydrogen ion concentrations than plant growth. This may be due to iron or aluminum toxicity or to actual calcium deficiency. It will be noted in Table 7 that lime applications did result in considerable increases in both soil pH and available calcium content of the soil.

Examples of typically well nodulated and poorly nodulated legume roots are presented in Figure 1.

It was of interest to note that Medicago contained significantly higher concentrations of both N and P than the other two legumes. This may be an inherent characteristic of the crop or it may be related to the generally lower yield of Medicago. Phosphate applications had a small but significant effect on both the N and P content of the roots, but lime applications had no measurable effect on composition.

## SUMMARY

A field experiment was conducted to determine the effect of phosphate and lime on the establishment, productivity, nodulation, and persistence of Desmodium intortum, Medicago sativa, and Stylosanthes gracilis. Phosphate accelerated the rate of establishment of the legumes and significantly increased their dry matter production. Desmodium and Stylosanthes produced significantly higher dry matter yields than Medicago. Phosphate also increased the nodulation of all the legumes. Desmodium and Stylosanthes had a significantly higher nodulation rating than Medicago. The persistence of Desmodium and Medicago was enhanced with phosphate.

No significant response to liming was shown by either Desmodium or Stylosanthes. Liming did not affect the establishment, productivity, nodulation or persistence of these two legumes. Liming did increase the productivity and persistence of Medicago.

## ACKNOWLEDGMENT

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Table 1. The Effect of Phosphate and Lime on Total Dry Matter Production (Kilograms/Hectare) of Three Legumes for a Two-Year Period.

| | $P_2O_5$ (Kilograms/Hectare) | | | | Lime (Metric Tons/Hectare) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Legume | 0 | 112 | 224 | 448 | 0 | 2.5 | 5.0 | 10.0 | MEAN* |
| *Medicago sativa* | 11,827 | 16,867 | 20,070 | 21,370 | 15,322 | 20,294 | 18,950 | 15,568 | 17,534b |
| *Desmodium intertum* | 27,350 | 31,718 | 35,482 | 36,938 | 32,010 | 33,667 | 32,390 | 33,421 | 32,872a |
| *Stylosanthes gracilis* | 30,397 | 34,115 | 33,376 | 33,588 | 31,886 | 33,936 | 33,331 | 32,323 | 32,869a |
| MEAN* | 23,191d | 27,567c | 29,643ab | 30,632a | 26,406a | 29,299a | 28,224a | 27,104a | 27,758 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 2. Total Dry Matter Production (Kilograms/Hectare) of Three Legumes for Four Growing Seasons

| | 1ST YEAR - 1968/69 | | 2ND YEAR - 1969/70 | |
|---|---|---|---|---|
| Legume | 1st Season Long Rains (March-August) | 2nd Season Short Rains (September-February) | 3rd Season Long Rains (March-August) | 4th Season Short Rains (September-February) |
| Medicago sativa | 4,996b* | 2,263c | 6,367c | 3,909c |
| Desmodium intortum | 7,123a | 7,661b | 8,449ab | 9,639a |
| Stylosanthes gracilis | 5,802b | 9,878a | 8,962a | 8,227ab |

*Means followed by the same letter are not different at the 1% level of significance.

Table 3. The Effect of Phosphate and Lime on Legume Nodulation Rating**

| | $P_2O_5$ (Kilograms/Hectare) | | | | Lime (Metric Tons/Hectare) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Legume | 0 | 112 | 224 | 448 | 0 | 2.5 | 5.0 | 10.0 | MEAN* |
| *Medicago sativa* | 5.21 | 6.04 | 9.06 | 8.65 | 5.78 | 7.38 | 7.88 | 7.94 | 7.24b |
| *Desmodium intortum* | 12.54 | 14.04 | 15.75 | 16.67 | 16.00 | 12.50 | 14.25 | 14.75 | 14.75a |
| *Stylosanthes gracilis* | 16.75 | 18.50 | 20.13 | 18.25 | 20.00 | 18.00 | 21.63 | 14.00 | 18.41a |
| MEAN* | 11.50b | 12.86ab | 14.98a | 14.52a | 13.93a | 12.63a | 14.58a | 12.73a | 13.47 |

*Means followed by the same letter are not different at the 1% level of significance.

**Rated from 1 (low) to 100 (high)

Table 4. The Effect of Phosphate and Lime on the Percentage Legume in the Stand after 2 Years

| | $P_2O_5$ (Kilograms/Hectare | | | | Lime (Metric Tons/Hectare) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Legume | 0 | 112 | 224 | 448 | 0 | 2.5 | 5.0 | 10.0 | MEAN* |
| *Medicago sativa* | 29 | 50 | 54 | 54 | 32 | 49 | 47 | 59 | 47c |
| *Desmodium intortum* | 76 | 81 | 88 | 87 | 80 | 88 | 85 | 78 | 83a |
| *Stylosanthes gracilis* | 80 | 75 | 76 | 76 | 76 | 72 | 76 | 82 | 77ab |
| MEAN* | 62b | 69ab | 73a | 72ab | 63b | 70ab | 69ab | 73a | 69 |

*Means followed by the same letter are not different at the 1% level of significance for legumes and phosphate. Means followed by the same letter for lime are not different at the 5% level of significance.

Table 5. The Effect of Phosphate and Lime on the Percentage N in Legume Roots

| | $P_2O_5$ (Kilograms/Hectare) | | | | Lime (Metric Tons/Hectare) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Legume | 0 | 112 | 224 | 448 | 0 | 2.5 | 5.0 | 10.0 | MEAN* |
| *Medicago sativa* | 1.40 | 1.38 | 1.49 | 1.53 | 1.33 | 1.46 | 1.53 | 1.48 | 1.45a |
| *Desmodium intortum* | 0.99 | 1.04 | 1.11 | 1.06 | 1.02 | 1.13 | 1.03 | 1.02 | 1.05b |
| *Stylosanthes gracilis* | 1.06 | 1.14 | 1.25 | 1.17 | 1.18 | 1.10 | 1.13 | 1.20 | 1.15b |
| MEAN* | 1.15c | 1.19abc | 1.28a | 1.25ab | 1.18a | 1.23a | 1.23a | 1.23a | 1.22 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 6. The Effect of Phosphate and Lime on the Percentage P in the Legume Roots

| Legume | $P_2O_5$ (Kilograms/Hectare) | | | | Lime (Metric Tons/Hectare) | | | | MEAN* |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 112 | 224 | 448 | 0 | 2.5 | 5.0 | 10.0 | |
| *Medicago sativa* | 0.087 | 0.096 | 0.148 | 0.190 | 0.122 | 0.138 | 0.119 | 0.141 | 0.130a |
| *Desmodium intortum* | 0.066 | 0.076 | 0.095 | 0.112 | 0.085 | 0.089 | 0.087 | 0.087 | 0.087b |
| *Stylosanthes gracilis* | 0.064 | 0.070 | 0.089 | 0.091 | 0.085 | 0.079 | 0.074 | 0.076 | 0.078b |
| MEAN* | 0.072c | 0.081c | 0.111b | 0.131a | 0.097a | 0.102a | 0.093a | 0.101a | 0.098 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 7. Analysis of Soil Samples Obtained at the Conclusion of the Legume Study

| Legume | Lime Tons/Ha | $P_2O_5$ Kg/Ha | pH | O.M. % | P ppm | Ca mg/100g |
|---|---|---|---|---|---|---|
| Medicago sativa | 0 | 0 | 5.6 | 3.5 | 2 | 102 |
| | | 112 | 5.6 | 3.6 | 4 | 109 |
| | | 224 | 5.5 | 3.5 | 7 | 106 |
| | | 448 | 5.5 | 3.5 | 29 | 125 |
| | 2.5 | 0 | 6.1 | 3.3 | 5 | 162 |
| | | 112 | 5.8 | 3.6 | 6 | 169 |
| | | 224 | 5.8 | 3.7 | 10 | 150 |
| | | 448 | 5.8 | 3.2 | 27 | 194 |
| | 5.0 | 0 | 6.2 | 3.5 | 6 | 187 |
| | | 112 | 6.3 | 3.9 | 10 | 212 |
| | | 224 | 6.3 | 3.5 | 12 | 200 |
| | | 448 | 6.0 | 3.5 | 31 | 200 |
| | 10.0 | 0 | 6.2 | 3.4 | 8 | 181 |
| | | 112 | 6.4 | 3.1 | 22 | 250 |
| | | 224 | 6.6 | 3.5 | 29 | 269 |
| | | 448 | 6.5 | 3.5 | 50 | 294 |
| Desmodium intortum | 0 | 0 | 5.4 | 3.7 | 4 | 137 |
| | | 112 | 5.6 | 4.1 | 6 | 144 |
| | | 224 | 5.6 | 4.0 | 10 | 156 |
| | | 448 | 5.7 | 3.2 | 18 | 150 |
| | 2.5 | 0 | 5.9 | 3.8 | 5 | 156 |
| | | 112 | 6.0 | 3.5 | 9 | 181 |
| | | 224 | 6.1 | 3.1 | 16 | 175 |
| | | 448 | 6.0 | 3.4 | 34 | 162 |
| | 5.0 | 0 | 6.2 | 3.1 | 7 | 175 |
| | | 112 | 6.3 | 3.3 | 16 | 219 |
| | | 224 | 5.8 | 3.1 | 10 | 162 |
| | | 448 | 6.1 | 2.9 | 53 | 212 |
| | 10.0 | 0 | 6.2 | 3.5 | 8 | 200 |
| | | 112 | 6.7 | 3.4 | 39 | 419 |
| | | 224 | 6.5 | 3.4 | 20 | 231 |
| | | 448 | 6.8 | 3.2 | 60 | 425 |

Table 7. Continued

| | Lime<br>Tons/Ha | $P_2O_5$<br>Kg/Ha | pH | O.M.<br>% | P<br>ppm | Ca<br>mg/100g |
|---|---|---|---|---|---|---|
| Stylosanthes gracilis | 0 | 0 | 5.4 | 3.2 | 2 | 99 |
| | | 112 | 5.6 | 3.1 | 11 | 107 |
| | | 224 | 5.6 | 3.2 | 10 | 100 |
| | | 448 | 5.7 | 3.5 | 31 | 137 |
| | 2.5 | 0 | 6.1 | 3.4 | 6 | 169 |
| | | 112 | 6.4 | 3.3 | 58 | 269 |
| | | 224 | 6.1 | 3.3 | 36 | 175 |
| | | 448 | 5.9 | 3.2 | 20 | 150 |
| | 5.0 | 0 | 6.2 | 3.1 | 6 | 187 |
| | | 112 | 6.5 | 3.2 | 14 | 219 |
| | | 224 | 6.2 | 3.5 | 16 | 206 |
| | | 448 | 6.3 | 3.1 | 54 | 231 |
| | 10.0 | 0 | 6.6 | 3.2 | 15 | 287 |
| | | 112 | 6.6 | 3.2 | 18 | 287 |
| | | 224 | 6.6 | 3.2 | 10 | 325 |
| | | 448 | 6.3 | 3.4 | 47 | 175 |

## Appendix F

RESEARCH REPORT
CONTRACT USAID/afr-411

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C.S.6

### TITLE

# The Effect of Large Applications of Nitrogen Fertilizer on the Productivity and Protein Content of Four Tropical Grasses

Soil fertility is an important factor affecting the productivity of leys in areas of adequate rainfall within the tropics. One of the most outstanding soil-nutrient deficiencies in most parts of the tropics is nitrogen. The maintenance and improvement of grass leys can be achieved through the application of adequate amounts of nitrogen fertilizer together with the required amounts of phosphate and potash. Numerous studies conducted in the tropics evaluating the response of grasses to nitrogen were reviewed by Henzell (1962). Earlier studies in East Africa have generally been limited to assessing the effect of light applications of nitrogen fertilizer. However, the levels of N were not adequate to fully exploit the production potential of the grasses evaluated. In the tropics, as elsewhere, it is important to explore the response curve of grass yields over a wide range of N applications.

In a preliminary investigation on the influence of fertilizers applied to natural grassland in Kenya, Poultney (1959) reported a substantial increase in dry matter production from the application of 2 1/2 cwt per acre of sulphate of ammonia. Dougall (1954 b) in the Kenya Highlands obtained a response to nitrate of soda and sulphate of ammonia applied to molasses grass pasture at the rates of 18 and also 36 pounds of nitrogen per acre. In another study, he (1954 a) observed a response from the use of sulphate of ammonia on Rhodes grass, molasses grass, cocksfoot and Kentucky fescue using up to 120 pounds of nitrogen per acre. In the Kenya Highlands, Birch (1959) evaluated the response of perennial ryegrass to sulphate of ammonia. Grass yields were increased using up to 123 pounds of nitrogen per acre. The effects of nitrogen fertilizer on grazed and cut elephant grass leys was explored in Uganda at the

Kawanda Research Station by Stephens (1967). He found that nitrogen increased the yield and protein content of elephant grass. In the cases where the grass was cut and removed, potash and magnesium fertilizers were necessary to maintain yields after the first year.

Considerable work on tropical pastures has been conducted in Puerto Rico. Vincente-Chandeler et al. (1959) tested nitrogen rates ranging from 0 to 1600 pounds of actual nitrogen per acre per year on napier grass, Guinea grass and para grass. The grasses responded strongly up to 800 pounds of actual nitrogen per acre per year.

This study was undertaken to compare the productivity and protein content of four tropical grasses when subjected to high rates of nitrogen fertilizer.

## EXPERIMENTAL PROCEDURE

This study was conducted at Makerere University Farm, Kabanyolo located about 19 km from Kampala, Uganda. The upland soils of Kabanyolo are classified as latosols or as ferralitic soils. These are deep, highly weathered and leached, fine textured, well-drained red soils. The experimental site had been in field crops for a number of years.

The climate at Kabanyolo is classified as moist tropical. Mean maximum temperatures vary from 28.5°C in January to 26.0°C in July, minimum temperatures from 17.4°C in April to 15.9°C in July and August. Annual rainfall is about 1300 mm with two peaks in April and November and two lows in January and July when mean monthly falls are about 60 mm.

A split-plot experimental design with five replications was employed to study the responses of Congo signal grass (*Brachiaria ruziziensis*), Rhodes grass (*Chloris gayana*), Guinea grass (*Panicum maximum*), and Nandi setaria (*Setaria sphacelata*) to various rates of nitrogen fertilizer. The main plots were the four grasses. The sub-plots consisted of nitrogen treatments. Each sub-plot was 2.1 m x 6.1 m.

Extremely large amounts of nitrogen were applied. The annual rates used were 0, 224, 448, 896, 1568 and 2240 kg/ha of actual N. The fertilizer was applied in six split applications using calcium ammonium nitrate (26 percent N). Applications were made every two months starting in January, 1968, and continuing through November, 1969.

The grasses were sown during October, 1967, in rows spaced 30 1/2 cm apart. Single superphosphate and muriate of potash at the rate of 49 kg/ha of P and 93 kg/ha of K were incorporated in the seedbed prior to planting. Thereafter, the same rate of P and K were used annually. However, K was applied in a split application twice annually at the beginning of each growing season.

Harvesting was done when individual grass species attained the early heading growth stage using an 'Allen Scythe' mower. A 0.9 m x 4.3 m strip was cut from the middle of each plot to determine dry matter production. Harvesting commenced in March, 1968, and continued for two years.

Herbage samples from every plot each harvest were analyzed for dry matter and nitrogen content. Crude protein content was calculated using the factor 6.25 times total Kjeldahl N content. Samples from two of the harvests in both the dry and rainy seasons were also analyzed for nitrate nitrogen. All chemical analyses were determined using standard analytical procedures.

The data were analyzed statistically using Analysis of Variance. The significant differences among treatments were tested with Duncan's Multiple Range Tests.

## RESULTS

The effect of N fertilizer on the annual dry matter production of the four grasses is presented in Table 1. C. gayana produced significantly more dry matter than S. sphacelata and B. ruziziensis. However, there was no real difference in dry matter yield between C. gayana and P. maximum. The grasses exhibited a strong response to N up to 448 kg/ha with a slight additional response up to 896 kg/ha. Above 896 kg/ha of N, there was an actual decline in dry matter production. The mean dry matter yields of the grasses with different levels of N ranged from 8.7 to 25.4 MT/ha per annum. It is noteworthy that dry matter production of the grasses increased almost threefold with high rates of N.

The influence of N on the accumulative yields of B. ruziziensis, C. gayana, P. maximum and S. sphacelata is given in Figures 1, 2, 3 and 4. C. gayana was harvested nine times. B. ruziziensis and P. maximum were each harvested eight times. S. sphacelata was harvested seven times per annum. Very little grass growth occurred during the dry seasons of the year. The effects of the various N treatments became more obvious with each successive harvest.

The effect of N fertilizer on the mean crude protein percent of the grasses for all harvests is shown in Table 2. S. sphacelata had the highest crude protein content but was not significantly higher than P. maximum. B. ruziziensis had the lowest crude protein content. The mean crude protein percent of the grasses increased with increasing increments of N from 7.9 to 16.5.

The total annual crude protein production of the grasses at different N levels is given in Table 3. C. gayana produced the largest amount of total crude protein. S. sphacelata yielded the smallest amount of crude protein. The mean total crude protein production of the grasses increased from 0.8 to 3.8 MT/ha with increasing increments of N up to 1658 kg/ha.

The influence of N fertilizer on the percent nitrate in the four grasses during the rainy season is reported in Table 4. P. maximum had a significantly higher content of nitrate than C. gayana and S. sphacelata. However, there was no real difference between P. maximum and B. ruziziensis. S. sphacelata had the lowest nitrate percent. It was not significantly different than C. gayana, however. The mean nitrate percent in the grasses in the rainy season increased with increasing increments of N from 0.054 to 0.348.

The influence of N fertilizer on the percent nitrate in the grasses during the dry season is found in Table 5. P. maximum had the highest nitrate level but was not significantly higher than B. ruziziensis. S. sphacelata had the lowest content of nitrate. Generally, the nitrate in the grasses increased as larger amounts of N were applied. The mean nitrate percent in the grasses in the dry season increased from 0.078 to 0.198 with increasing increments of N. At the low N levels, the content of nitrate in the grasses was higher during the dry season. However, at the higher rates of N, the amount of nitrate in the grasses was considerably higher during the rainy season.

## DISCUSSION

Nitrogen fertilizer benefits grass leys by increasing herbage dry matter yields and enhancing the crude protein percent and protein yield per unit area of sward. However, the full benefits from the application of large amounts of N can only be realized if care is taken to incorporate both phosphate and potash in required amounts. If this is done, increasing the amount of fertilizer applied will result in higher stocking rates and increased productivity per hectare.

In most of the studies reported in a review by Henzell (1962), yields of tropical grasses, as determined by cutting techniques, increased in proportion to the quantity of N fertilizer at low and intermediate rates of application. Within limits, there is a straight line response but with heavier rates of N the law of diminishing returns operates and ultimately yields are depressed by excessive quantities of fertilizer. The grasses in this study gave a strong response to N up to 448 kg/ha. The yields leveled off at 896 kg/ha of N although total crude protein production increased through the 1568 kg/ha application rate of N. The increment of N above this level depressed dry matter yields. This decrease may be attributable to fertilizer injury to the plants. Some foliage burning and loss of plant population was evident.

_G. gayana_ was the most productive species but was not significantly better than _P. maximum_. It also had the fastest rate of recovery after cutting. _S. sphacelata_ was the least productive but was not significantly different than _B. ruziziensis_.

In East Africa, nitrogen deficiency and inadequate soil moisture are the most limiting factors in grass production. With applied nitrogen and ample soil water (rainfall and/or irrigation), growth is continuous throughout the year. In this study, very little growth of the grasses was noted during the dry seasons. With shortages of herbage during the dry seasons of the year and excesses during the rainy seasons, the conservation of surplus herbage as hay or silage merits careful consideration. As an alternative, the use of irrigation during the dry seasons of the year would probably result in even higher dry matter yields. Also with irrigation a more uniform herbage production throughout the year would possibly be obtained. This is especially important in dairying. During the dry season, the sky is generally less overcast so irrigation water with the prevailing higher light intensities would enhance the net assimilation rate of the grasses leading to higher dry matter yields. Split applications, rather than a single huge application, are suggested. This results in less fluctuation in herbage yields. Also, possible losses of N through volatilization, leaching and erosion are minimized.

The quantities of N profitably utilized for high producing tropical grassland exceed the rates normally used in temperate zones. This may be partly the result of high growth rates of the grasses and a longer growing period during the year.

The most economic levels of dry matter production usually require much less N than for maximum yields. Even with massive doses of N applied in Puerto Rico by Rodriguez (1949) and Little _et al._ (1959), the most efficient production per unit of fertilizer was obtained at the lower rates--200-400 lb of N/acre annually.

Presumably with the return of excreted N during grazing, it would be possible to obtain the same amount of feed with somewhat less fertilizer, perhaps 2/3 of the rate giving the best return in a mowing experiment. The results of this experiment indicate that there was no real advantage in applying more than 448 kg/ha of N per annum.

Generally in the tropics grass production, energy values, and crude protein percent are low. Often a shortage of proteins exists. This is accentuated by the fact that in many areas of the tropics an all purpose legume is not available. N had a marked effect on the quality of herbage produced in this study as indicated by the C. P. percent in the dry matter. The mean C. P. percent at the highest level of N was 16.5, almost twice as high as the check treatment. The C. P. percent appeared to increase with N fertilizer rates beyond the levels that gave the maximum dry matter production. S. spacelata generally had a slightly higher C. P. percent probably because of the lower yields produced. With proper N fertilization, all the grasses had high protein levels. If legumes are not planted in leys in association with grasses, the use of N to enhance productivity and C. P. percent may be valuable.

C. gayana produced the largest amount of total crude protein. The total crude protein of the grasses increased in direct relation to the amount of N applied since the added increments of N elevated both the C. P. percent and dry matter yield. The greatest efficiency of total crude protein yield occurred at a somewhat higher level of N than the optimum for dry matter production.

The protein content of a grass that is harvested will be influenced to a considerable extent by the timing of the sample cuts. Harvesting in this study was done when individual grass species attained the early heading stage of growth. Cutting at an earlier stage of growth would result in a low yield of higher-protein material while harvesting at a later stage would produce greater yield of lower quality. The timing of N fertilization is also another important factor.

Nitrate is the form of N removed from the soil in greatest quantities by plants. Generally, it is rapidly converted to protein. However, occasionally nitrate accumulates in plants because the soil may be extremely rich in it. The abundant supply of nitrate in the soil may be attributable to decaying organic matter, manure or commercial fertilizers. Other factors that greatly affect the concentration of nitrates in plants are N/S ratio plant species, the part of the plant, the stage of maturity and light intensity. Feeds high in nitrate have been reported to cause deaths of ruminant animals, loss in milk production, abortion and loss of weight. Bradley et al. (1940) reported that levels of 0.20 percent could be toxic to livestock. Little *et al*. (1959) detected only traces of nitrates in tropical grasses that could be toxic to cattle even at the highest level of 1600 lb/acre of N per annum. The results of this study, however, indicate that annual N rates of 896 kg/ha and above could result in nitrate concentrations potentially dangerous to livestock. Such large N applications, however, would not normally be made in agronomic practice.

## SUMMARY

A field experiment was conducted to determine the effect of large applications of nitrogen fertilizer on the productivity and protein content of *Brachiaria ruziziensis*, *Chloris gayana*, *Panicum maximum* and *Setaria sphacelata*. All the grasses responded strongly to N up to 448 kg/ha with a slight additional response up to 896 kg/ha. Above this level, there was a decline in dry matter yield. *C. gayana* produced significantly more dry matter than *S. sphacelata* and *B. ruziziensis*. There was no real difference in yield between *C. gayana* and *P. maximum*. Nitrogen increased the dry matter production of the grasses almost threefold. The mean dry matter yields of the grasses ranged from 8.7 to 25.4 MT/ha per annum.

The mean crude protein percent of the grasses more than doubled using high rates of N. It varied from 7.9 to 16.5 percent. *S. sphacelata* had the highest crude protein content but was not significantly higher than *P. maximum*. *C. gayana* produced the largest amount of total crude protein, whereas *S. spacelata* yielded the lowest amount.

The nitrate content in the grasses increased with increasing increments of N. Concentrations potentially dangerous to livestock were found at the higher N treatments.

## ACKNOWLEDGMENT

Support for this research from USAID/afr-411 contract with West Virginia University is gratefully acknowledged.

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Table 1. The Effect of Nitrogen Fertilizer on the Mean Annual Dry Matter Production (MT/ha) of Four Grasses.

| Grass | Rate of N Application (Kg/ha) | | | | | | MEAN* |
|---|---|---|---|---|---|---|---|
| | 0 | 224 | 448 | 896 | 1568 | 2240 | |
| *Brachiaria ruziziensis* | 6.1 | 13.9 | 21.8 | 26.5 | 25.9 | 23.5 | 19.6bc |
| *Chloris gayana* | 11.2 | 20.7 | 24.5 | 27.8 | 26.0 | 25.4 | 22.6a |
| *Panicum maximum* | 9.7 | 18.9 | 25.6 | 24.9 | 25.7 | 22.9 | 21.3ab |
| *Setaria sphacelata* | 7.6 | 17.7 | 19.3 | 22.0 | 24.1 | 19.8 | 18.4c |
| MEAN* | 8.7f | 17.8e | 22.8bcd | 25.3a | 25.4ab | 22.9bc | 20.5 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 2. The Effect of Nitrogen Fertilizer on the Crude Protein Percent of Four Grasses.

| Grass | Rate of N Application (kg/ha) | | | | | | MEAN* |
|---|---|---|---|---|---|---|---|
| | 0 | 224 | 448 | 896 | 1568 | 2240 | |
| *Brachiaria ruziziensis* | 6.7 | 7.7 | 10.1 | 13.9 | 16.3 | 16.8 | 11.9d |
| *Chloris gayana* | 8.5 | 9.3 | 11.2 | 14.3 | 15.7 | 15.5 | 12.4c |
| *Panicum maximum* | 8.7 | 9.4 | 11.1 | 14.7 | 16.1 | 16.5 | 12.8ab |
| *Setaria sphacelata* | 7.8 | 9.6 | 11.9 | 14.7 | 16.4 | 17.3 | 13.0a |
| MEAN* | 7.9e | 9.0e | 11.1d | 14.4bc | 16.1ab | 16.5a | 12.5 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 3. The Annual Total Crude Protein Production (MT/ha) of Four Grasses at Different Levels of Nitrogen Fertilizer.

| Grass | Rate of N Application (kg/ha) 0 | 224 | 448 | 896 | 1568 | 2240 | MEAN* |
|---|---|---|---|---|---|---|---|
| *Brachiaria ruziziensis* | 0.6 | 1.2 | 2.4 | 3.6 | 4.1 | 3.9 | 2.6c |
| *Chloris gayana* | 1.1 | 1.9 | 2.8 | 3.9 | 3.9 | 3.9 | 2.9a |
| *Panicum maximum* | 1.0 | 1.9 | 2.5 | 3.6 | 3.8 | 3.7 | 2.8b |
| *Setaria sphacelata* | 0.5 | 1.6 | 2.1 | 3.2 | 3.6 | 3.3 | 2.4d |
| MEAN** | 0.8e | 1.7de | 2.5cd | 3.6abc | 3.9a | 3.7ab | 2.7 |

*Means followed by the same letter are not different at the 5% level of significance.

**Means followed by the same letter are not different at the 1% level of significance.

Table 4. The Influence of Nitrogen Fertilizer on the Percent Nitrate Nitrogen in Grasses During the Rainy Season.

| Grass | Rate of N Application (kg/ha) 0 | 224 | 448 | 896 | 1568 | 2240 | MEAN* |
|---|---|---|---|---|---|---|---|
| *Brachiaria ruziziensis* | 0.045 | 0.056 | 0.093 | 0.205 | 0.372 | 0.386 | 0.193ab |
| *Chloris gayana* | 0.034 | 0.033 | 0.047 | 0.161 | 0.296 | 0.325 | 0.149 |
| *Panicum maximum* | 0.068 | 0.063 | 0.050 | 0.350 | 0.434 | 0.445 | 0.235a |
| *Setaria sphacelata* | 0.069 | 0.065 | 0.076 | 0.099 | 0.197 | 0.237 | 0.124c |
| MEAN* | 0.540d | 0.054d | 0.067d | 0.204c | 0.325ab | 0.348a | 0.175 |

*Means followed by the same letter are not different at the 1% level of significance.

Table 5. The Effect of Nitrogen Fertilizer on the Percent Nitrate Nitrogen in Grasses During the Dry Season.

| Grass | Rate of N Application (kg/ha) | | | | | | MEAN* |
|---|---|---|---|---|---|---|---|
| | 0 | 224 | 448 | 896 | 1568 | 2240 | |
| *Brachiaria ruziziensis* | 0.080 | 0.096 | 0.076 | 0.105 | 0.220 | 0.223 | 0.133a |
| *Chloris gayana* | 0.062 | 0.078 | 0.057 | 0.120 | 0.208 | 0.210 | 0.123b |
| *Panicum maximum* | 0.078 | 0.071 | 0.065 | 0.155 | 0.223 | 0.248 | 0.140a |
| *Setaria sphacelata* | 0.090 | 0.108 | 0.104 | 0.083 | 0.107 | 0.109 | 0.100c |
| MEAN** | 0.078e | 0.088d | 0.076e | 0.116c | 0.190ab | 0.198a | 0.124 |

*Means followed by the same letter are not different at the 5% level of significance.

**Means followed by the same letter are not different at the 1% level of significance.

## Appendix G

## PROGRESS REPORT
## CONTRACT USAID/afr-411

PAUL G. MOE
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

824/RB

### TITLE

A Study of Root Distribution and Nutrient Uptake of the Banana Plant

### INSTITUTION WHERE RESEARCH IS BEING CARRIED OUT

Makerere University
P. O. Box 7062
Kampala, Uganda

### TIME PERIOD COVERED

October 1, 1970 to January 1, 1971

### DESCRIPTION OF RESEARCH CARRIED OUT

A field experiment was initiated at Makerere University Farm at Kabanyolo to study the effect of phosphate uptake by banana plants, mates, usually consisting of one mother plant and one or two followers, were selected on the basis of uniformity within a large established banana plantation. Sixteen equidistantly spaced holes were dug in a ring around the mother plant in each mat. Holes were dug to depths of 0, 15, 30 and 60 cm at distances of 40, 80, 120 and 160 cm from the mother plant. Treatments were replicated three times making a total of 48 treated mats of bananas in the experiment. A glass vial containing 4 ml of radioactive phosphate solution was crushed in each hole on November 24, 1970, the beginning of the dry season which normally lasts for about three months. A total of 5 mC of P-32 was applied to each mat in the form of a solution of $KH_2PO_4$ containing 1000 ppm phosphorus. Leaf samples were taken from the third fully opened leaf of the mother plant at 10 and 20 days after the treatment. Additional samples will be taken after 30 and 40 days. The leaf samples were all dried at 105° overnight and then 10 gm of dried ground leaf material was ashed at 450° for 6 hours. The ash was weighed and a 0.250 gm aliquot was then used for determining P-32 activity using the Geiger-Muller end window method. Counts per minute per gram of dry leaf material were calculated and then all counts were corrected to the date of application and for K-40. The results are presented in Tables 1 and 2.

## CONCLUSIONS DRAWN

Both distance from mother plant and depth of placement treatments were significant at the 1 percent confidence level at both samplings when analyzed by analysis of variance. However, there was also a highly significant interaction between treatments at both samplings. When placed close to the mother plant, a shallow depth of placements resulted in the greatest P-32 uptake. When placed further away from the mother plant, the deeper placements were more effective. Further samplings will be analyzed in a similar fashion to determine whether this trend continues and to determine which is the best position for fertilizer placement over a longer period of time.

Table 1. Actual Counts Per Gram of Dry Leaf Material Collected 10 Days After Treatment (Means of Three Replications).

| Depth of Placement (cm) | Distance From Mother Plant (cm) 40 | 80 | 120 | 160 | Depth Means |
|---|---|---|---|---|---|
| 0 | 1590 | 1149 | 55 | 169 | 741a |
| 15 | 219 | 201 | 75 | 417 | 228b |
| 30 | 70 | 80 | 398 | 185 | 183b |
| 60 | 99 | 19 | 43 | 6 | 42b |
| Distance Means | 494a | 362ab | 143b | 194b | |

Table 2. Actual Amounts Per Gram of Dry Leaf Material Collected 20 Days After Treatment (Means of Three Replications.

| Depth of Placement (cm) | Distance From Mother Plant (cm) 40 | 80 | 120 | 160 | Depth Means |
|---|---|---|---|---|---|
| 0 | 1848 | 1247 | 33 | 178 | 826a |
| 15 | 693 | 530 | 298 | 856 | 594a |
| 30 | 251 | 179 | 1356 | 318 | 526a |
| 60 | 219 | 129 | 88 | 31 | 116b |
| Distance Means | 753a | 521ab | 444ab | 346b | |

# Appendix H

# PROGRESS REPORT
# CONTRACT USAID/afr-411

W. A. van ECK
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

## A.E.1

## TITLE

Kerita Tea Irrigation Project

Experimental design and treatments were presented in earlier reports. The present report covers the years 1968 and 1969 and some additional recent data. It summarizes the more detailed and extensive report and exerts significant management conclusions.

The summarized data is presented in the attached tables. Yields have been at very high levels, 30-50 percent above estate yields on average, with individual treatments performing even better. There was a drop from 1968 to 1969 yields except for a slight rise at the highest N levels. This was probably associated with the less favorable water balance of 1968.

Response to irrigation (Tables 1 and 2) is slightly positive when all N treatments are combined. The best response was obtained at 100 N and 200 N levels, but with prevailing tea prices these responses were not profitable. If dry periods were judged separately, the response was more striking but still uneconomical. For a favorable response to added water, some N needs to be applied but high N levels show a negative response to irrigation, though this is not significant.

Response to nitrogen is always positive (Tables 3 and 4). In 1968 with smaller overall yields, the responses to N were much smaller than in 1969. The 1968 responses were rather linear to the 200 N level but tapered off at 300 pounds, whereas in 1969 the responses were roughly linear. The responses in 1968 were not economical at any level of N application, but in 1969 they were for all levels of N provided no irrigation was applied.

The interactions of nitrogen and irrigation treatments were non-significant.

There is abundant supporting data on crop water balance and water use, soil moisture levels, soil water discharge and recharge, soil nutrient levels, foliar analyses of various parts of the crop, taken at various times during the experiment. Also, pruning weights were taken early in 1970 and regrowth was counted by treatment. These data are part of the comprehensive report but are not essential to the points raised above.

The data presented in summary have had important repercussions on the management of tea at Kerita and elsewhere. The negative or uneconomic response to irrigation has cautioned many estates into reconsidering their management plans and saved millions of shillings to those concerned. There are justified criticisms that the Kerita studies have not yet experienced a true (normal?) dry season or calendar year to test the more adverse conditions of the 1950's which initiated the irrigation development around the country. It is for this reason that the current experiment is extended to early 1971 so as to allow for another year of study of this point. Also, the pruning weights showed significant response to N at all levels and it is felt that the regrowth of these bushes since May, 1970 should be followed for at least one year to study the cumulative benefits of improved management.

Many marginal results have come from the experiment. Most important, plucking schedules have been reduced to four to five days on average so that more regrowth is plucked at the optimal stage and less 'banjhi' growth is permitted. Leaf discharge in the research plots is now insignificant compared to the commercial estate.

K levels have been questioned without appreciation by the Tea Research Institute until early 1970 news came that their ashing procedures had been incorrect, causing a 25 percent error of judgment. By new standards Kerita is K deficient and a new subtrial is laid down to study ways to correct this. It is combined with N treatments at high levels but excludes irrigation.

The assistance of Mr. F. Luyiga and the pleasant cooperation of the Estate Manager, Mr. F. Mwehaire, is again gratefully acknowledged. Mr. D. Stephens who took over the administration of the project in December, 1969, was of considerable help before he departed in June, 1970, after which Dr. Moe administered on behalf of Agricultural Enterprises Limited.

Current plans are to continue Kerita research work until April, 1971, after which the Tea Research Institute will continue (Dr. M. Carr) with whom we have had periodic contact. An internal report was prepared for the General Manager, Agricultural Enterprises Limited, dealing with specific management decisions. The larger report is in various stages of completion for final issuance in April, 1971.

Table 1. Summary of Response to Irrigation Regardless of Nitrogen Level (Lb of Made Tea, Corrected to 21 Percent Moisture)

| Treatment | | Yield | | Response Over Control | |
|---|---|---|---|---|---|
| | Block | 1968 | 1969 | 1968 | 1969 |
| No irrigation | D | 3049 | 2701 | | |
| | I | 2600 | 2279 | | |
| | J | 2851 | 2792 | | |
| | M | 2256 | 2255 | | |
| | Mean | 2689 | 2507 | | |
| Medium irrigation | B | 3057 | 2912 | | |
| | F | 3208 | 2782 | | |
| | G | 2732 | 2215 | | |
| | K | 2341 | 2198 | | |
| | Mean | 2834 | 2527 | +145 | +20 |
| Heavy irrigation | C | 3324 | 2977 | | |
| | E | 2842 | 2549 | | |
| | H | 2653 | 2492 | | |
| | L | 2729 | 2409 | | |
| | Mean | 2887 | 2607 | +198 | +100 |

Note: Figures are means of four replicates.

Table 2. Summary of Response to Irrigation for Different Nitrogen Treatments (Lb/A of Made Tea, 21 Percent Moisture)

| | 1968 | | | | 1969 | | | |
|---|---|---|---|---|---|---|---|---|
| Lb/A N | 0 | 100 | 200 | 300 | 0 | 100 | 200 | 300 |
| Irrigation Treatment | | | | | | | | |
| Control | 2287 | 2397 | 2934 | 3138 | 1636 | 2160 | 2784 | 3446 |
| Medium | 2241 | 2761 | 3134 | 3201 | 1590 | 2227 | 2979 | 3317 |
| Response | -46 | +364 | +200 | +63 | -46 | +67 | +195 | -129 |
| High | 2183 | 3149 | 3149 | 3067 | 1468 | 2650 | 3014 | 3294 |
| Response | -104 | +752 | +215 | -71 | -168 | +490 | +230 | -152 |

Note: Figures are means of four replicates.
Profit margin response with any irrigation level without nitrogen is about 1500 lb/a (assuming irrigation cost 300.00/acre/annum and tea value 0.20/lb on bush).

Table 3. Summary of Response to Nitrogen Regardless of Irrigation Level (Lb/A of Made Tea, 21 Percent Moisture)

| Lb/A N | 1968 | 1969 | Profit Margin Response |
|---|---|---|---|
| Control | 2237 | 1563 | |
| 100 | 2769 | 2346 | |
| Response | +532 | +783 | +500 |
| 200 | 3072 | 2926 | |
| Response | +835 | +1363 | +1000 |
| 300 | 3135 | 3352 | |
| Response | +898 | +1789 | +1500 |

Note: Figures are means of twelve plots.
Profit margin response represents yield increase needed to pay for added cost over control, assuming tea value = 0.20/ lb on bush and N costs 1.00/lb after application.

Table 4. Summary of Response to Nitrogen at Different Irrigation Levels (Lb of Made Tea, 21 Percent Moisture)

| | 1968 | | | 1969 | | |
|---|---|---|---|---|---|---|
| Lb/A N | Dry | Med. | Wet | Dry | Med. | Wet |
| Control | 2287 | 2241 | 2183 | 1636 | 1590 | 1468 |
| 100 | 2397 | 2761 | 3149 | 2160 | 2227 | 2650 |
| Response | +110 | +520 | +966 | +524 | +637 | +1182 |
| 200 | 2934 | 3134 | 3149 | 2784 | 2979 | 3014 |
| Response | +647 | +893 | +966 | +1148 | +1389 | +1546 |
| 300 | 3138 | 3201 | 3067 | 3446 | 3317 | 3294 |
| Response | +851 | +960 | +884 | +1810 | +1727 | +1826 |

Note: Figures are means of four replicates.
Profit margin response without irrigation is an follows (in lb of made tea) 100 N: 500 lb, 200 N: 1000 lb, 300 N: 1500 lb. With irrigation add 1500 lb to each of these figures (assuming cost of irrigation = 300.00/a/year, cost of N = 1.00/lb N, and value of tea = 0.20/lb on bush).

KERITA IRRIGATION PROJECT (MAKERERE/AEL)

Experimental Yield Response (in lb. of Made Tea/Acre/yr, 21 Percent Moisture)

| | | | 1968 | | 1969 | |
|---|---|---|---|---|---|---|
| | 1968 | 1969 | Dry Periods | Wet Periods | Dry Periods | Wet Periods |
| IRRIGATION RESPONSE | | | | | | |
| Irrigation Treatment | | | | | | |
| None = Dry (Control) | 2689 | 2507 | 2156 | 3023 | 2899 | 2412 |
| Medium | 2834<br>(+145) | 2527<br>(+20) | 2436<br>(+280) | 3083<br>(+60) | 2923<br>(+24) | 2284<br>(-128) |
| High = Wet | 2887<br>(+198) | 2607<br>(+100) | 2488<br>(+332) | 3144<br>(+121) | 2960<br>(+61) | 2379<br>(-33) |
| NITROGEN RESPONSE | | | | | | |
| N Treatment | | | | | | |
| None (Control) | 2237 | 1563 | 1908 | 2465 | 1921 | 1440 |
| 100 N | 2769<br>(+532) | 2346<br>(+783) | 2317<br>(+409) | 3056<br>(+601) | 2522<br>(+601) | 2284<br>(+844) |
| 200 N | 3072<br>(+835) | 2926<br>(+1363) | 2605<br>(+697) | 3364<br>(+899) | 3439<br>(+1518) | 2648<br>(+1208) |
| 300 N | 3135<br>(+898) | 3352<br>(+1789) | 2712<br>(+804) | 3437<br>(+972) | 3835<br>(+1914) | 3054<br>(+1614) |

Means of 12 Plots

Means of 4 Plots

Each plot contains 10 x 14 = 140 bushes

KERITA IRRIGATION PROJECT (MAKERERE/AEL)

Experimental Yield Responses (in lb. of made tea/acre/yr, 21 percent moisture)

|  | Irrigation Treatment | 1968 |  |  | 1969 |  |  |
|---|---|---|---|---|---|---|---|
|  |  | D | M | W | D | M | W |
|  | Nitrogen Treatment |  |  |  |  |  |  |
| Nitrogen Response | 0 N (Control) | 2287 | 2241 | 2183 | 1636 | 1590 | 1468 |
|  | 100 N (Yield) | 2397 | 2761 | 3149 | 2160 | 2227 | 2650 |
|  | 100 N (Response) | +110 | +520 | +966 | +524 | +637 | +1182 |
|  | 200 N (Yield) | 2934 | 3134 | 3149 | 2784 | 2979 | 3014 |
|  | 200 N (Response) | +647 | +893 | +966 | +1148 | +1389 | +1546 |
|  | 300 N (Yield) | 3138 | 3201 | 3067 | 3446 | 3317 | 3294 |
|  | 300 N (Response) | +857 | +960 | +884 | +1810 | +1727 | +1826 |
| Irrigation Response | 0 N (Response | control | -46 | -104 | C | -46 | -168 |
|  | 100 N (Response) | control | +364 | +752 | C | +67 | +490 |
|  | 200 N (Response) | control | +200 | +215 | C | +195 | +230 |
|  | 300 N (Response) | control | +63 | -71 | C | -129 | -152 |

Legend:

| N Treatments |  |
|---|---|
| 0 N | No N applied |
| 100 N | 100 lb/acre/year |
| 200 N | 200 lb/acre/year |
| 300 N | 300 lb/acre/year |

| Irrigation Treatments |  |  |
|---|---|---|
| D | No irrigation |  |
| M | 3" irrigation when soil water deficit | 3" |
| W | 1" irrigation when soil water deficit | 1" |

KERITA IRRIGATION PROJECT (MAKERERE/AEL (CONTINUED)

Experimental Yield Responses (in lb. of made tea/acre/yr, 21 percent moisture)

| | | 1968 | | | | | | 1969 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dry Periods | | | Wet Periods | | | Dry Periods | | | Wet Periods | | |
| | Irrigation Treatment | D | M | W | D | M | W | D | M | W | D | M | W |
| Nitrogen Response | Nitrogen Treatment | | | | | | | | | | | | |
| | 0 N (Control) | 1801 | 1959 | 1965 | 2637 | 2415 | 2342 | 1973 | 1890 | 1899 | 1442 | 1443 | 1441 |
| | 100 N (Yield) | 1828 | 2355 | 2769 | 2772 | 3015 | 3382 | 2458 | 2421 | 2666 | 2439 | 2005 | 2412 |
| | 100 N (Response) | +27 | +396 | +804 | +135 | +600 | +1040 | +485 | +531 | +767 | +997 | +562 | +969 |
| | 200 N (Yield) | 2453 | 2669 | 2693 | 3230 | 3426 | 3435 | 3235 | 3472 | 3612 | 2550 | 2684 | 2708 |
| | 200 N (Response) | +653 | +710 | +728 | +593 | +1011 | +1093 | +1258 | +1588 | +1713 | +1108 | +1241 | +1257 |
| | 300 N (Yield) | 2544 | 2760 | 2584 | 3460 | 3476 | 3374 | 3932 | 3909 | 3664 | 3195 | 3016 | 2951 |
| | 300 N (Response) | +743 | +801 | +619 | +823 | +1061 | +1032 | +1959 | +2019 | +1765 | +1853 | +1573 | +1510 |
| Irrigation Response | 0 N (Response | C | +158 | +164 | C | -122 | -295 | C | -83 | -74 | C | +1 | -1 |
| | 100 N (Response) | C | +527 | +941 | C | +243 | +610 | C | -37 | +208 | C | -434 | -27 |
| | 200 N (Response) | C | +213 | +240 | C | +196 | +205 | C | +237 | +377 | C | +134 | +158 |
| | 300 N (Response | C | +216 | +40 | C | +16 | -86 | C | -23 | -268 | C | -197 | -244 |

Legend:

| N Treatments | | Irrigation Treatments | |
|---|---|---|---|
| 0 N | No N applied | D | No irrigation |
| 100 N | 100 lb/acre/year | M | 3" irrigation when soil water deficit 3" |
| 200 N | 200 lb/acre/year | W | 1" irrigation when soil water deficit 1" |
| 300 N | 300 lb/acre/year | | |

# Appendix I

## PROGRESS REPORT
## CONTRACT USAID/afr-411

RICHARD T. WURSTER AND PAUL G. MOE
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

## S.S.1-5

### TITLE

The Response of Mulched Pineapple to Urea Nitrogen Applications

### DATE OF INITIATION

October 31, 1968

The ratoon crop will be harvested and the yield data tabulated and statistically analyzed. This project should be terminated by December 31, 1971.

### PERSONNEL

Dr. R. T. Wurster--Project Leader (Department of Crop Science and Production)
Dr. Paul G. Moe --Project Leader (Department of Soil Science and Agricultural Chemistry)

### SUMMARY OF PREVIOUS WORK

A split-split plot design field plot experiment was established at Kabanyolo Farm in November, 1968. The two main plot treatments were different types of propagating material (crowns vs. suckers and slips). The two sub-plot treatments were irrigation (weekly irrigation vs. no irrigation). The twelve sub-plot treatments were three mulching practices (bare fallow vs. elephant grass mulch vs. black polyethylene mulch) and four levels of urea-nitrogen application (0, 150, 300 and 600 lbs N/acre). The first fruit was harvested in February, 1970.

## PROGRESS DURING PAST YEAR

Fruit was harvested from all plots once a week for a total of 26 harvests. Data from individual harvests have all been tabulated and statistically analyzed using an IBM 360 computer. Cumulative crop yields are now being analyzed. Cumulative crop yields are presented in Tables 1, 2 and 3 below. The results indicated many highly significant differences. In regard to propagating material, there were no significant differences in total amount of fruit harvested but the slips and suckers started producing marketable fruit six weeks earlier than the crowns. Weekly irrigation significantly depressed total cumulative yields, but a strong response to urea nitrogen applications was noted. Elephant grass mulch was better than bare fallow but black polyethylene mulch was superior to both.

Nitrogen treatments were repeated after the plant crop had been harvested and the first ratoon crop is now ready for harvest.

## GENERAL COMMENTS

This experiment has shown that mulching treatments have a very marked effect on pineapple yields. Additional experiments are required to ascertain exactly what this effect is due to.

## RESEARCH RESULTS

See Tables 1, 2 and 3.

Table 1. The Effects of Irrigation and Rate of Urea-Nitrogen Application on Total Pineapple Fruit Yields (Metric Tons/Ha).

| | Rate of Urea-Nitrogen Application (Lbs/Acre) | | | | |
|---|---|---|---|---|---|
| | 0 | 150 | 300 | 600 | Means |
| Non-Irrigated | 84.2 | 93.2 | 97.7 | 102.6 | 94.4 |
| Irrigated | 71.9 | 84.5 | 84.3 | 90.2 | 82.7 |
| Means | 78.0 | 88.8 | 91.0 | 96.4 | 88.6 |

Table 2. The Effects of Irrigation and Mulch Treatments on Total Pine-Apple Fruit Yields (Metric Tons/Ha).

| | Bare Fallow | Elephant Grass | Black Plastic | Means |
|---|---|---|---|---|
| Non-Irrigated | 90.0 | 94.3 | 99.9 | 81.9 |
| Irrigated | 74.8 | 83.8 | 89.5 | 82.7 |
| Means | 81.9 | 89.1 | 94.7 | 88.6 |

Table 3. The Effects of Mulch Treatments and Rate of Urea-Nitrogen Application on Total Pineapple Fruit Yields (Metric Tons/Ha).

| | Rate of Urea-Nitrogen Application (Lbs/Acre) | | | | |
|---|---|---|---|---|---|
| | 0 | 150 | 300 | 600 | Means |
| Bare Fallow | 62.6 | 86.1 | 84.0 | 95.0 | 81.9 |
| Elephant Grass | 81.7 | 89.6 | 91.3 | 93.6 | 89.1 |
| Black Plastic | 89.8 | 90.8 | 97.7 | 100.6 | 94.7 |
| Means | 78.0 | 88.8 | 91.0 | 96.4 | 88.6 |

## Appendix J

## RESEARCH PROJECT
## CONTRACT USAID/afr-411

FARREL J. OLSEN
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

### C.S.3

### TITLE

The Mineral Composition of East African Grasses and Legumes

### JUSTIFICATION

In 1970, a cooperative study between the Departments of Crop Science (F. J. Olsen) and Animal Science (J. Mugerwa) of Makerere University College, Kampala, Uganda, and the Division of Animal and Veterinary Sciences (R. L. Reid and Amy J. Post), West Virginia University, Morgantown, West Virginia, was initiated. As part of this study, samples of approximately 40 grasses and 12 legumes grown at Kabanyolo, Uganda, were harvested at a succession of growth stages (weekly intervals during the early growth cycle, two weekly intervals at later stages of maturity) from February-June, 1970. In all, a total of 650 to 700 samples were collected. These samples are presently being analyzed using the artificial rumen and detergent extraction procedures to provide estimates of digestible energy content and animal intake values. These data will provide a basis for the selection of species and varieties of grasses and legumes of superior nutritive value for ruminant animals, and will also enable recommendations to be made on the optimum time of grazing or harvesting the forage crop.

As part of this study, a limited number of mineral analyses of grass and legume samples at an early growth stage has been performed. The analysis has included phosphorus, potassium, calcium, magnesium, sodium, silicon, iron, aluminum, magnanese, boron, strontium, zinc, copper, barium and molybdenum. The data indicate that there are wide species and variety differences in the ability of tropical grasses and legumes to accumulate specific major and minor elements and, further, that certain elements--for example, magnesium and sodium--are present in extremely low concentration. On a field scale, such deficiencies might be expected to give rise to metabolic abnormalities and lowered production in animals grazing the herbage. It has also been demonstrated, in work at West Virginia (Reid, et al., 1969) that a deficiency of one or more mineral elements in a plant may reduce the digestibility and overall utilization of the herbage.

For these reasons, it is proposed to perform a complete mineral analysis on a number of grasses and legumes at all stages of their growth cycle. The species selected will include both indigenous types, e.g., Hyparrhenias, Themedas, Cymbopogons, and the promising introduced species, e.g., Setarias, Brachiarias, Chloris, Panicums, Stylosanthes, Desmodium, Glycine, etc.

The results of this study will provide useful information on factors influencing the mineral content of forage crops grown under defined conditions in Uganda. The amount of such information is presently limited. Bredon (1964) reported on the mineral requirements of cattle in Uganda and, more recently, Thornton, et al. (1969), Long, et al. (1969) and Long, et al. (1970) have discussed the mineral status of soils and pastures in the areas of Buganda, Busoga, Ankole, and the Queen Elizabeth National Park. Such studies have, in the main, been designed to sample natural pastures or rangelands in Uganda at rather extended intervals and with a limited number of forage species. No study has yet defined the changing pattern of mineral composition in a wide variety of grass and legume plants over a complete growth cycle.

## OBJECTIVES

The objective of this study will be to provide a detailed mineral analysis on a variety of grass and legume species harvested at regular intervals during a 16-week growth period from February-June, 1970, at Makerere University Farm, Kabanyolo, Uganda. The results of this analysis will be used (a) to provide information on the major and minor element composition of East African forage plants and, specifically, to define potential deficiency or toxicity states as they may be related to problems of animal production or metabolism in a tropical environment, (b) to interpret the nutritive value of data obtained using sheep and the artificial rumen technique on the same plant samples.

## PROCEDURE

Samples taken from a range of grasses and legumes (see attached list) will be analyzed for phosphorus, potassium, calcium, magnesium, sodium, silicon, iron, aluminum, magnesium, boron, copper, zinc, strontium, barium and molybdenum. The analysis will be run on a series of growth stages from the early vegetative phase to the late seeding stage for each series. Mineral composition curves will be constructed for each species and composition will be assessed in relation to the established growth and maintenance requirements of ruminant livestock (Whitehead, 1966; A.R.C., 1966) Correlation and regression analysis will be used to define the relationship of mineral components of plant species to their estimated *in vitro* digestibility.

Soil samples will be obtained for analysis of soil pH, organic matter, available phosphorus, potassium, calcium, magnesium and total bases and for micronutrients (sulfate, boron, zinc, manganese, copper, iron, molybdenum and sodium).

## PERSONNEL

Dr. F. J. Olsen, Pasture Agronomist, Department of Crop Science and Production, Faculty of Agriculture, Makerere University.

Dr. J. Mugerwa, Animal Nutritionist, Department of Animal Science and Production, Faculty of Agriculture, Makerere University.

Dr. R. L. Reid, Animal Nutritionist, Department of Animal Industry and Veterinary Science, College of Agriculture and Forestry, West Virginia University.

## DURATION OF STUDY

Six months

## BUDGET

The cost of analysis for mineral composition of plants by emission spectrophotometry (Ohio Agricultural Experiment Station) is $4 per sample. It is proposed to analyze 300 samples of plant material at a total cost of $1,200. Soil samples will be analyzed by the United States Testing Company (Richland, Washington) at a cost of $105. The cost of statistical analysis and publication of results will be covered by the terms of the original project "The Nutritive Evaluation of East African Grasses and Legumes."

## PUBLICATION OF RESULTS

Data and results will be made available to the Uganda Ministries of Agriculture and Animal Industries, Game and Fisheries.

The results will be published as research bulletins of the Faculty of Agriculture of Makerere University and as articles in professional journals.

## REFERENCES

Reid, R. L., G. A. Jung and Amy J. Post. 1969. "Effects of Micro-Element Fertilization on the Nutritive Quality of Orchardgrass." J. An. Sci. 29:181.

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Thornton, D. D., M. I. E. Long and B. Marshall. 1969. "The Mineral Status of Dairy Farms in the Parts of Buganda and Busoga Bordering Lake Victoria, Uganda. I. General Ecology and Soils." Trop. Agr., Trin. 46:269-78.

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Agricultural Research Council (London). 1966. "The Nutrient Requirements of Farm Livestock. No. 2, Ruminants: Technical Reviews."

Whitehead, D. C. 1966. "Nutrient Minerals in Grassland Herbage." Commonwealth Bureau Pasture and Field Crops Mimeo. Publ. 1/1966.

## Appendix K

RESEARCH PROJECT
CONTRACT USAID/afr-411

RICHARD T. WURSTER
FACULTY OF AGRICULTURE
MAKERERE UNIVERSITY

### C.S.9

### TITLE

Potato Improvement Project for Uganda
Proposed Budget Request, Five-Year Timetable

### INTRODUCTION

The following proposed budget for a Potato Improvement Project for Uganda is based on a cooperative effort between the Ministry of Agriculture and Makerere University, with the Ministry of Agriculture managing the production of "improved seed" and its distribution to growers at the District Farm Institute, Kabale, Kigezi and Makerere University assisting with the research, developmental and technical phases of the project at the University Farm, Kabanyolo, Kampala.

The Potato Improvement Project as planned on a five-year timetable at the end of which the production of "Foundation Seed" at the D. F. I. and the production of "Improved Seed" by outgrowers could be at a level sufficient to supply all the seed requirements in the Kigezi District. It is also intended that the potato seed multiplication scheme will be entirely self-sufficient at the end of the five-year period through the sale of seed potatoes to growers. In order to accomplish these objectives, it will be necessary to recruit new staff, construct new facilities and purchase the needed equipment and supplies. The proposed budget is organized on the basis of expenditures at Kabale and Kabanyolo for the first year of the project and for the five-year duration of the project.

# POTATO IMPROVEMENT PROJECT FOR UGANDA
# PROPOSED BUDGET REQUEST*
# FIVE-YEAR TIMETABLE

KABALE (District Farm Institute, Kachwekano, Kigezi)

| Staff Positions: (New) | 1st Year (shs) | 5th Year (shs) |
|---|---|---|
| 1. Assistant Agricultural Officer | 16,000 | 80,000 |
| N.B.: The A.A.C. would be assigned full-time to the potato improvement project. His duties would include overall supervision of the research plots at the DFI in addition to management of the potato multiplication scheme, distribution of seed advising growers | | |
| 2. Field Assistant (Farm School Graduate) | 3,600 | 18,000 |
| N.B.: The field assistant would be resident at the DFI, Kachwekano. His duties would be the daily management of the field plots and the supervision of casual labor. | | |
| 3. Casual Labor | 38,880 | 194,440 |
| 4 porters and 1 watchman per acre in production (5 acres initially) = 600-man-day equivalents, per month rate = shs. 5/40 | | |
| N.B.: Casual labor would be used as required for maintenance of research plots and for multiplication of seed for distribution to growers. | | |
| **Buildings and Construction:** | | |
| Seed store (common storage for potato seed) 20 x 40 feet, Murram block-concrete construction, shs. 30/-per square foot. | 24,000 | 24,000 |
| N.B.: The store would be used solely for the storage of seed potatoes. | | |

Potato Improvement Project for Uganda (Continued)

| | 1st Year (shs) | 5th Year (shs) |
|---|---|---|
| **Equipment:** | | |
| 1. 1 Landmaster equipped with rotovator | 3,850 | 3,850 |
| 2. Ox-drawn equipment | | |
| (a) Ariana duel purpose plow and ridger | 1,300 | 1,300 |
| (b) Harness including ox chains, yoke, halters, etc. | 200 | 200 |
| 3. Solo Mist blower, portable, pack-mounted, 3 h.p. power sprayer and duster. Capacity for application of pesticides to 5 acres. | 2,500 | 2,500 |
| 4. Hand tools | | |
| (a) 75 hoes @shs. 6/-each | 300 | 300 |
| (b) 10 basins (karai), @shs. 5/-each | 50 | 50 |
| (c) 3 steel drums, (44-gal) @50/-each | 150 | 150 |
| (d) 2 field scales (Chatillon) with tripod, @shs. 350/-each | 700 | 700 |
| **Supplies:** | | |
| 1. Fertilizers | | |
| (a) Calcium-ammonium nitrate, 150 lbs N/A per year shs. 365/75 per ton | 570 | 2,850 |
| (b) Single super phosphate, 100 lbs $P_2O_5$/A per year shs. 295/-per ton | 306 | 1,530 |
| 2. Pesticides | | |
| (a) Thimet, granular systemic insecticide, 20 lbs., active per acre per year, shs. 3/-per lb. | 300 | 1,500 |
| (b) Aldrin, soil insecticie, 5 lbs. active per acre, shs. 8/75 per lb. | 214 | 1,070 |
| (c) Malathione, 5 gal., @shs. 70/-per gallon | 350 | 1,750 |
| (d) DDT, 5 gal., @23/50 per gallon | 118 | 590 |
| (e) Cupertor disinfectant, 5 gal. per year, @shs. 36/-per gallon | 180 | 900 |

Potato Improvement Project for Uganda (Continued)

| | 1st Year (shs) | 2nd Year (shs) |
|---|---|---|
| 3. Field stakes and labels and bags | | |
| (a) 5,000 painted, wooden stakes, @shs. -/30 | 1,500 | 1,500 |
| (b) 10,000 metal tags, shs. 75/-per 1,000 | 750 | 750 |
| (c) 20,000 net bags, 5 lb. capacity, @shs. -/20 | 4,000 | 4,000 |
| (d) 5,000 net bags, 25 lb. capacity, @shs. -/50 | 2,500 | 2,500 |
| (e) 1,000 gunny sacks, 100 lb. capacity, @shs. 1/- | 1,000 | 1,000 |
| Fencing: | | |
| 1. Cost of fence poles (including erection) shs. 450/-per acre | 2,250 | 2,250 |
| 2. Fence wire, shs. 200/-per acre | 1,000 | 1,000 |
| Irrigation System: | | |
| 1. Wade-rain irrigation system, capacity = 3,600 gph, 15 h.p. motor, 640 ft. 3-inch aluminum main, 480 ft. 2-inch aluminum laterals, 20 series A sprinkler nozzles, and 20 series B 40 p.s.i. nozzles. Complete with all connections, couplings and outlet valves | 16,165 | 16,165 |
| 2. Booster pump, including 10 h.p. motor | 3,400 | 3,400 |
| N.B.: A booster pump is required to lift irrigation water from the outlet at the DFI Farm to the proposed irrigation reservoir. | | |
| 3. PVC underground irrigation mains, 3-inch, 600 yds., @shs. 3/25 per ft. | 5,850 | 5,850 |
| 4. Concrete block reservoir, dimensions = 30 x 30 x 5 1/2 feet, capacity = ca. 30,000 gal. | | |
| (a) Labor: to be constructed on the site at the DFI, Kachwekano, using casual labor (already included) | | |

Potato Improvement Project for Uganda (Continued)

| | 1st Year (shs) | 5th Year (shs) |
|---|---|---|
| (b) Materials: | | |
| 6 lorry loads of stone @shs. 80/- | 480 | 480 |
| 4 lorry loads of sand @shs. 100/- | 400 | 400 |
| 70 bags cement @shs. 18/- | 1,260 | 1,260 |
| Miscellaneous: | | |
| N.B.: A miscellaneous category is calculated on 5 percent of the total budget. It is intended to cover incidental expenses including electricity to operate pumps, repair to equipment, freight and transport, miscellaneous items such as gum boots, paint, brushes, etc. | 3,765 | 18,810 |
| Sub-total | Shs. 137,885/- | 395,135/- |

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*Prepared in consultation with:

1. District Agricultural Officer, Kigezi
2. Assistant Agricultural Officer, Kigezi
3. Principal, District Farm Institute, Kigezi.

Based on data from Memorandum "Potato Development Scheme for the Kigezi District." Produce Marketing Board, Kampala, 1968.

## PROPOSED FUTURE POTATO SEED CERTIFICATION SCHEME FOR UGANDA

| | |
|---|---|
| FOUNDATION SEED | FOUNDATION SEED FARM<br>DFI, KABALE<br>Total acreage = 8 acres<br>Estimated yield per acre = 5 tons<br>Annual production = 40 tons |
| CERTIFIED SEED | MINISTRY OF AGRICULTURE<br>CERTIFIED SEED FARMS<br>Total acreage = 80 acres<br>Seed requirement = 40 tons<br>Estimated yield per acre = 5 tons<br>Annual production = 400 tons<br>Value* = Shs. 179,200 |
| IMPROVED SEED | KIGEZI DISTRICT<br>IMPROVED SEED OUTGROWERS<br>Total acreage = 800 - 830 acres<br>Seed requirement = 400 tons<br>Yield per acre = 3 tons<br>Annual production = 2,500 tons<br>Value* = Shs. 1,120,000 |
| MARKET POTATOES | KIGEZI DISTRICT<br>MARKET POTATO PRODUCERS<br>Total acreage = 5,000 acres<br>Seed requirement = 2,500 tons<br>Yield per acre = 3 tons<br>Annual production = 15,000 tons<br>Value* = Shs. 6,720,000 |

*Value estimated on basis of Kampala wholesale price of -/20 per lb.

Table 1. Estimated Acreage Under Potato Production in Uganda

| | | |
|---|---|---|
| Buganda | | 550 Acres |
| Toro | | 500 Acres |
| Bunyoro | | 400 Acres |
| Ankole | | 200 Acres |
| West Nile | | 500 Acres |
| Bugisu/Sebei | | 5,000 Acres |
| Kigezi | | 10,000 Acres |
| Others | | 250 Acres |
| | Total | 17,400 Acres |

Table 2. Recorded Potato Acreages and Exports in Tons from the Kigezi District.*

| Year | Acres | Tons Exported |
|---|---|---|
| 1934 | 5,000 | n.a. |
| 1945 | 100 | n.a. |
| 1946 | 171 | n.a. |
| 1947 | 1,587 | n.a. |
| 1948 | 3,556 | 470 |
| 1949 | 5,429 | 450 |
| 1950 | 7,350 | 250 |
| 1951 | 7,598 | 693 |
| 1952 | 7,521 | 360 |
| 1953 | 8,599 | 663 |
| 1954 | 9,032 | 712 |
| 1955 | 10,520 | 650 |
| 1956 | 8,623 | 331 |
| 1957 | 11,900 | 226 |
| 1958 | 9,873 | 327 |
| 1959 | 10,457 | 161 |
| 1960 | 10,262 | 64 |
| 1961 | 11,544 | 111 |
| 1962 | 4,297 | --- |
| 1963 | 4,834 | 130 |
| 1964 | 4,981 | 145 |
| 1968 | 8,000 | 400-500 (Est) |

*District Agricultural Files

Reproduced from Memorandum "Potato Development Scheme for the Kigezi District." Produce Marketing Board, Kampala, 1968.

Table 3. Potato Imports Into Uganda, 1964-1967

| Year | | Kenya | Tanzania | Total |
|---|---|---|---|---|
| 1964 | lbs. | 2,836,800 | 71,900 | 2,908,700 |
| | Value | 25,977 | 608 | 26,585 |
| 1965 | lbs. | 5,034,700 | 21,300 | 5,056,000 |
| | Value | 44,961 | 228 | 45,189 |
| 1966 | lbs. | 6,610,500 | -- | 6,610,500 |
| | Value | 58,440 | -- | 58,440 |

Table 4. Potato Prices at Various Levels in Cts. Per Lb., 1965-1968*

| | 1965/66 | 1967 | 1968 |
|---|---|---|---|
| Average Farm Price Kigezi | 10-12 | 12-15 | 13-22 |
| Average Farm Price Kenya | 4-10 | 8-12 | 10-20 |
| Average Wholesale Price Kampala | 12-20 | 18-25 | 20-30 |
| Average Tender Price Kampala | 20-23 | 20-25 | 23-30 |
| Average Retail Price | 25-30 | 30-40 | 30-50 |

*Every year during the April-June period, prices tend to rise for short periods above the average mentioned in Table 4.

Reproduced from Memorandum "Potato Development Scheme for the Kigezi District." Produce Marketing Board, Kampala, 1968.

## Appendix L

## REPORTS ON THE LAST THREE INTERNATIONAL CONFERENCES ATTENDED BY WVU STAFF MEMBERS

### XI INTERNATIONAL GRASSLAND CONGRESS

### QUEENSLAND, AUSTRALIA

Approximately 1,000 delegates from 49 different countries of the world attended the XI International Grassland Congress held on the 13th to 23rd of April, 1970, in Queensland, Australia.

There were three general sessions running concurrently and were as follows:

A. Management and use of pastures and forage
B. Physiology of pasture and forage plants
C. Plant improvement and seed production

My main interests were in the management and use of pastures and forage. Consequently, most of the papers I heard given were in that general session. However, I did attend the other sessions whenever there was a paper given of particular interest to me.

It is not possible in this report to review all of the papers presented at the Congress. They have been published and the proceedings exceed 1,000 pages total. However, I will attempt to cover briefly some of the more interesting papers which I heard.

Progress in developing tropical pastures in the wet tropical areas of the Caribbean was described by Dr. J. A. Richards of the Jamaican Government's pasture research unit. He reported that highly productive tropical grass pasture had been established and it seemed likely the region would become self sufficient in animal products soon. He also reported that nearly all of the highly productive grasses for the region had been introduced from tropical Africa.

The relative merits of bagged nitrogen and pasture legumes as sources of nitrogen for grasses was discussed at length at the conference. A Dutch scientist presented positive evidence showing that extremely high rates of fertilizer nitrogen do not adversely affect the health of grazing animals. Dr. D. Browne from Ireland described the response of Irish pastures to various levels of nitrogen fertilizer and the effect of the fertilizer upon the proportion of clover in the sward.

Pastures top-dressed with high rates of nitrogen rarely contained clover. Mr. H. Rogers suggested that pasture varieties selected for high levels of water-soluble carbohydrates or of organic acids should give better yield responses to applied nitrogen fertilizer than varieties selected only for high digestibility. All in all, it appears that the world grassland scientists cannot yet give clear-cut answers on the relative roles of legumes and nitrogen fertilizers as sources of nitrogen for grazed pastures.

Pasture scientists from the United States and Australia are exploring the possible use of computers to pre-test grazing management practices. Results so far are promising and suggest that in future years computer programs that simulate the extremely complex interactions between the pasture, the soil and the grazing animal might provide a practical guide to at least some aspects of management on commercial properties. Dr. Goodal of the United States described a computer program he developed to simulate the grazing situation in semiarid range lands. His computer program requires topographical, meteorological and soil information for different parts of the grazed paddock, and the qualities of forage of different plant species in distinct sections of the grazing area. Given such information, the computer will report as required the stock mortality, average sheep liveweights, wool production, total forage production, the soil moisture, and the weight of each of the main plant species in each portion of the paddock.

Dr. M. Freer from Australia developed a computer model to simulate the summer grazing by sheep. It calculates daily changes in the amount and digestibility of the feed available in the paddock, the actual diet eaten by the sheep and changes in their weight. The model has been used to predict the response of sheep weight to changes in grazing subdivision, stocking rate, rate of growth of the pasture, and grazing efficiency. Professor G. Van Dyne, a world authority on the systems approach to pasture research and the computer-based mathematical modeling of grassland situations reported how such models can be devised and used. He suggested that they are a useful framework on which to hang our knowledge about grasslands, and the models are useful in making predictions but the predictions must be validated or tested in the field or laboratory.

Recent improvements in aerial camera systems, new types of film and advanced photo-measurement devices that in some instances allow the identification of individual plant species from large scale aerial vegetation photographs were discussed by a team from the USDA. They reported that the recently developed 70 mm aerial camera systems have significant advantages over conventional systems. They produce high-resolution stereophotography at scales as large as 1 in 600 as well as possessing a number of desirable and practical attributes, including the small format that allows uncut film to be viewed with a lens stereoscope.

Dr. D. O. Norris, a legume bacteriologist, reported that it was essential to introduce effective and specialized strains of root nodule bacteria that matched the new plants grown from introduced seed.

The plant breeders believe that the most important aspect in the breeding of improved pasture plants is the move from quantity to quality, as the major breeding objective. In other words, the worth of a new variety must be measured in terms of increased production of wool, meat and milk.

Dr. J. F. Loneragan of Australia discussed the discovery of the various soil mineral deficiencies including those elements which are required in only trace amounts by plants. The recognition of these deficiencies opened the way to their correction by fertilizers and the establishment of nitrogen-producing legumes over tens of millions of acres of lowly productive grassland in Australia. He pointed out that the dominance of superphosphate as a fertilizer for Australian pastures reflects the widespread occurrence of extreme phosphorus deficiency. Conversely, the very limited use of nitrogenous fertilizer reflects the fact that in most situations pasture legumes provide the nitrogen at less cost than would nitrogen fertilizer.

One of the highlights was the mid-Congress tour in Queensland. This two-day tour under semitropical conditions showed pasture research and development of beef cattle on the wet, infertile, sandy gleyed podzolic soils of the coastal lowlands north of Brisbane (rainfall approximately 1,600 mm). Useless native vegetation was replaced here by sown species with heavy fertilizing. The Beerwah Research Station of C.S.I.R.O. was visited. It had about 200 acres of grazing trials on pastures of grass-legume mixtures and on grass fertilized with nitrogen. Over 2,000 hectares of legume based pastures and several thousand cattle were observed at Caloundra Downs a commercial property.

At the Coolum Research Station of the Queensland Department of Primary Industries nurseries and grazing trials on wet heath county were seen. At all these centers, a range of subtropical grasses and legumes could be seen.

The coastal plateau of Maleny, an old established dairying area, was visited. Pastures of Paspalum dilatum, kikuyu and white clover have replaced the original rainforest on kraznosem soils. The tour included some attractive coastal and mountain scenery and passed through some of the tropical fruit growing areas. The most important thing I gleaned from this tour was the fact that the Australians really know how to grow excellent tropical grass/legume pastures. They are growing many of the same species that are being planted in pastures in East Africa. I learned the techniques necessary to establish and maintain good legume/grass pastures in the tropics.

At the Congress, I made contacts with other scientists in other parts of the world who were working on similar problems with tropical pasture species. We were able to exchange ideas and discuss our current research activities. I was able to observe the developments being made in Queensland, Australia, by scientists and farmers in pasture development in the tropics. The pasture work was well advanced and there were many techniques which they are employing which could be used here in East Africa to enhance pasture productivity. My professional competence as a teacher and researcher has been improved through my attendance at the Congress. I am sure that many of the new ideas and much of the information given at the meetings will be of great benefit in my work at Makerere University.

I express my sincere thanks to those who made it possible for me to attend the conference.

Farrel J. Olsen

## XIV INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS

### MINSK, USSR

The conference was attended by approximatley 800 delegates from 44 countries. The largest representation came from the U.S.S.R. and the U.S.A. Unfortunately, very few Africans attended and only a few economists working in Africa were in attendance. The only African countries represented by Africans were Kenya, Nigeria, Sierra Leone and Uganda (Dr. Oloya). The total contingent of economists from Africa amounted to only 12 delegates.

Despite the small number of delegates from Africa, there was much interest in locating the next conference (1973) in Nairobi. The Kenya Government did not send a formal request nor did they make a monetary commitment to subsidize the conference if it is held in Nairobi. Brazil, on the other hand, sent an official request and a pledge of U.S. $150,000 to support the conference if held in Sao Paulo. The organizing committee elected to give the Kenya Government an opportunity to request that the conference be held in Nairobi. If they do not make a formal bid by the end of 1970, the next conference will be held in Brazil. If the conference in 1973 were held in Nairobi it would be the first time on the African continent.

One of the highlights of the conference was the paper by Gunnar Myrdal of Sweden, Agricultural Development and Planning in Underdeveloped Countries Outside the Socialist Sphere. In his paper he pointed out the need for land reform and expressed the view that this could follow any number of routes ranging from expropriation from large landlords and divisions of land among the landless, to state farms, collective farms and improved private ownership of land in the more traditional manner of land purchase with title to it. His main concern was that the "green revolution" would be used as a reason for governments to pay less attention to agriculture and land reform because they will feel the food problems are solved.

Another concern by Myrdal was the problems which the "green revolution" would cause in creating greater iniquity in income among farmers, because those with fertile land and irrigation water would benefit most and most likely would not be taxed accordingly. Increased income on these farms would lead to greater mechanization and investment in labor saving machines with a net result of increased rural unemployment and ever increasing urban slums.. His plan was for more aid from rich countries and more redistribution of wealth from the cities to rural areas in developing countries to lessen rural poverty. Policy makers should be aware of the need for labor intensive production and should pursue these policies because of rapidly expanding rural population and lag in industrialization.

The discussion which followed this paper revealed divergent views on the prospects of the "green revolution" and its real effects on the future food supply to meet unchecked population growth. There were many economists who felt that food shortages will continue to exist if population expansion goes unchecked by positive programs to that end.

There were a series of papers on the general topic of planning and performance in agriculture, much of which was not new. The papers on planning Soviet agriculture were disappointing because they were focused on the performance of state and collective farms. They were merely a presentation of statistics on past performance and changes in farm numbers and output. Many delegates were unhappy because the Soviet economists did not get down to explaining the process of planning or it's overall validity in meeting targets. No mention was made of the small plot, private sector of Soviet agriculture, and even when the question was raised in the discussion section, no satisfactory report was given on its performance.

J. G. Waardenburg of the Netherlands spoke on regional planning within countries. He presented a mathematical model which could be used and was interested in its ease of calculation by desk calculators. The discussants stated that the problem of calculation machines was no serious problem because most countries now have access to computers. There were questions raised about the validity of results in the light of inadequate data in most developing countries.

A paper which was of interest to delegates from developing countries was presented by W. A. Wapenhans from IBRD. His topic was on the criteria used in international finance in agricultural development. He indicated the problems of international transfer of funds for agricultural development and the difficulties of choosing between the alternative demands for limited funds. The main criteria are the development potential of projects under consideration, credit worthiness of the borrowing country and prospects of success of the project. Project appraisal includes the opportunity cost for funds used. He pointed out that the role of economists was in providing economic appraisal of projects designed by engineers and agricultural scientists.

In the discussion session, the question was raised about the wisdom of continuing to channel the bulk of funds to large, long-term projects. The real need, which discussants felt was being overlooked, is for providing funds for short term capital to purchase improved seeds and fertilizer. There were some questions as to the dominant role played by non-economists in project design and appraisal, but Wapenhans defended the Bank's present policies. However, I doubt if he satisfied most economists at the conference with his views.

The marketing section of the conference was brief. The paper which was most interesting was presented by J. C. Abbott from FAO. He was primarily concerned with the need for more case studies in marketing research.

There were many other papers but those mentioned were the most interesting and provocative. The sectional meetings varied in subject matter and in quality. The problem, which arose in many, was the verbal communications difficulties due to language barriers. I attended the farm management sectional meetings which included a two-hour discussion on whether Soviet agriculture should be discussed in the same meetings as underdeveloped agriculture. This was never fully resolved, but the Soviet delegation decided to remain in this section. This resulted in a dichotomy in discussion and led to a less fruitful group of meetings than I expected. The Soviet economists impressed many economists from less developed countries with their economics of scale, but by North American or Australian standards they were not very startling.

In my estimation, one of the real highlights of the conference was the full day excursion to a collective farm, 125 kilometers west of Minsk. This was the most popular excursion which was attended by approximately 400 people. Most people were disappointed because the tour only included a meeting hall review of accomplishments and a question and answer session. The tour of the farm consisted of showing us a new dairy barn and upright silo. The question and answer period included some fairly candid remarks. The drive was interesting because we had an opportunity to observe the countryside and actually see people and machines at work in the fields. The most important activity was in putting up hay and preparing fields for seeding winter grains. Visitors to state farms had similar experiences to ours at the collective farm.

I did collect some interesting statistics about this particular collective farm which may be helpful in giving readers a picture of the performance of Soviet agriculture in this area. The social services on the farm seemed adequate including an outpatient clinic, hospital, schools and kindergarten. There were also facilities for recreation provided on the farm.

The farm itself consisted of 6,532 hectares of land, of which 5,629 were in agricultural land. The remainder was either swampy or in forest. The manager stated that plans are underway to drain the swampy areas. The emphasis on this farm was on animal production and a large part of the land was used in growing fodder crops. Soil was regarded as generally poor, light sandy clay loam. The average annual rainfall is 65 centimeters. The livestock on the farm in 1969 consisted of 4,224 head of cattle (including 1,384 cows) and 3,590 pigs. All labor intensive processes were mechanical. The point of pride was that one milkmaid could care for an average 950 cows.

| 1969 Production | Planned Target (1975) |
|---|---|
| 700 kg. flax-fibre per hectare | to increase sharply |
| 30,400 kg. sugar beets per hectare | 45,000 kg. per hectare |
| 22,400 kg. potatoes per hectare | 30,000 kg. per hectare |
| 4,500 kg. perennial grass hay per hectare | |
| 35,000 kg. food roots | |
| | 20,000 kg. meat and 100,000 kg. milk per 100 hectares |

The manager stated that he cannot purchase adequate supplies of fertilizer and this may be a constraint in meeting planned production targets. Barnyard manure is still considered an important source of fertilizer on this farm.

The 1969 gross income was 2,130,000 rubles, with a net profit of 940,000 rubles or a ratio of net income to costs of 49.2 percent. Costs were stated at 1,351,000 rubles. Official exchange rates are 1 ruble = $1.10 U.S.

For a farm which is largely concentrated on livestock production the input of machinery was high and the labor input seemed excessive. It had 78 tractors, 18 self-powered grain harvesters, 14 self-powered potato harvesters, and 38 lorries. There were 1,020 able-bodied workers (men and women) including 38 administrators. The farm also had 210 horses which were used in farm operations. The labor input was very high despite the large amount of machinery. I noticed that the hay-making process was done by antiquated equipment, by North American standards, because much hay was put up in stacks and that which was baled was done by stationary baling machines.

The conference was interesting and informative. By professional standards, the papers were not up to the level of the conference at Lyons, France, which I attended, nor that in Sydney, Australia, of which I read the proceedings. The level of discussion was a bit disappointing because discussion sessions were dominated by the Soviet and East European block. The Russians wanted to send 250 delegates but I was informed by one of the organizing committee members that they convinced them to reduce this to 125 delegates. Each discussion was usually dominated by a lineup of Russian, Bulgarian and Polish economists, which usually took most of the time available. I was also interested in noting that most economists from Russia and Eastern Europe were the older men, the younger men were not evident in the discussion sessions.

I am very happy to have had this opportunity to attend the conference and want to thank those who made it possible.

Victor F. Amann

## 14TH WORLD'S POULTRY SCIENCE CONGRESS

### MADRID, SPAIN

I, together with Mrs. Abbott, attended the 14th World's Poultry Science Congress held in Madrid, Spain, September 6-12. Unfortunately both of us contacted a respiratory ailment on our way to Madrid which kept us from attending much of the Congress and associated functions. However, I was able to be at some of the meetings and certainly benefited from the experience.

The Congress was held in the very modern and functional National Palace on Congresses in Madrid. Attendance was good, representing many countries around the world. A majority of papers presented indicated reasonably high technical competence in the various disciplines of poultry science and production. Simultaneous translations were made in English, French, Spanish and German, and this service was good. However, the overall organization of the meetings was only modestly successful.

A breakdown of the papers published in the abstracts into various disciplines of poultry science and production is given to indicate generally current research interests. It is as follows: genetics, 55; pathology, 67; physiology and nutrition, 133; housing and management, 19; production and economy, 26; industrialization and commerce, 19. Papers were presented from the following countries in the numbers indicated: Argentina, 5; Australia, 6; Belgium, 3; Brazil, 4; Canada, 8; Cuba, 2; Czechoslovakia, 4; Denmark, 6; Egypt, 3; France, 14; Germany, 24; Great Britain, 17; Holland, 10; Hungary, 2; Israel, 2; Italy, 1; Japan, 2; Philippines, 2; Poland, 3; Rhodesia, 1; Russia, 22; Spain, 16; Sweden, 1; United States, 71; Yugoslavia, 2. Subjects ranged from "Preliminary Studies on Goose Down" to "Yeast Grown on Gas Oil in Rations for Breeding Hens."

Very excellent commercial displays of poultry equipment, medicants and other products, and breeding stocks were located at the Fairgrounds in Madrid. Displays such as these are very helpful to one concerned with organizing and building facilities and programs in a developing country.

While visiting the displays of poultry equipment, I had an impromptu meeting with the representatives of a poultry equipment manufacturing company in Tel Aviv, Israel. I had visited that organization earlier this year and selected equipment especially appropriate for the present Poultry Unit at Kabanyolo. This meeting in Madrid provided an opportunity to discuss possibilities for various kinds of equipment available and types of buildings needed for the new poultry facility being planned at Kabanyolo. This information was sent immediately to our architects in Rome whom I had seen regarding the building plans for Kabanyolo on my way to Madrid.

Attendance at international conferences such as this also provides opportunities for rewarding discussions with new acquaintances as well as with old friends in the profession and industry. I value particularly my meeting for the first time at the Congress with poultry specialists from Liberia and Malawi and our discussions concerning poultry production in Africa.

I want to repeat that I regard this opportunity to attend the 14th World's Poultry Science Congress as a valuable experience and helpful in my work in Uganda. I am grateful for support from USAID Mission to Uganda for my transportation expenses and from Makerere University, Kampala, for living expenses while at the Congress.

Okra J. Abbott

## Appendix M

## 1968 SYLLABUS FOR THE B.Sc. (AGRICULTURE)
## MAKERERE UNIVERSITY

### NEW SYLLABUS FOR THE B.Sc. (AGRICULTURE)

(i) The syllabus as described below is divided into "course units." Each course unit is made up of 35-40 lecture equivalents in which one hour of lecture or seminar is considered equivalent to one excursion or two hours in a practical class. The entire three-year course is made up of 40 course units or approximately 1,500 lecture equivalents (17 per week).

(ii) The syllabus enables a choice of one of three options offered in the final year. These options are:

(a) Crop Production
(b) Animal Production
(c) Management and Extension

(iii) The course units offered in each year are listed below. The Course Number designates the department responsible for mounting the course; courses which are run on an interdepartmental basis are indicated with an asterisk, the course number indicating the department responsible for its administration.

| COURSE NO. | COURSE TITLE | COURSE UNITS |
|---|---|---|
| YEAR I | | |
| AC 101 | Inorganic and Physical Chemistry | 1 |
| AC 102 | Agricultural Chemistry | 1 |
| AC 103* | Microbiology | 1 |
| AE 101 | Agricultural Engineering | 1 1/2 |
| AS 101 | Zoology | 1 1/2 |
| CS 101 | Botany | 1 |
| CS 102 | Genetics | 1/2 |
| CS 103 | Plant Physiology | 1 |
| CS 104 | Agronomy I | 1 |
| CS 105* | Ecology | 1/2 |
| CS 106 | Entomology | 1/2 |
| RE 101 | Introduction to East African Agriculture | 1 |
| RE 102 | Agricultural Economics | 1 1/2 |
| | Total | 13 |

| COURSE NO. | COURSE TITLE | COURSE UNITS |
|---|---|---|
| **YEAR II** | | |
| AC 201 | Biochemistry | 1 |
| AC 202 | Geology and Soil Formation | 1/2 |
| AC 203 | Soil Physics | 1/2 |
| AC 204 | Soil Chemistry and Fertility | 1 |
| AE 201 | Soil/Water Engineering and Structures | 1 |
| AE 202 | Farm Mechanization | 1 |
| AS 201 | Feeds and Feeding | 1 |
| AS 202 | Animal Physiology | 1/2 |
| AS 203 | Livestock Management | 1 |
| CS 201 | Agronomy II (Annual Crops) | 1 |
| CS 202 | Agronomy III (Pasture Agronomy) | 1/2 |
| CS 203 | Principles of Crop Protection | 1 |
| CS 204 | Applied Statistics | 1 |
| RE 201 | Production Economics and Farm Management | 1 1/2 |
| RE 202 | Agricultural Extension and Rural Sociology | 1 1/2 |
| | Total | 14 |

YEAR II (Vacation Practical Training)

| | | |
|---|---|---|
| AC 250 | Soil Science | 1/2 |
| AE 250 | Agricultural Engineering and Surveying | 1/2 |
| AS 250 | Animal Production | 1/2 |
| CS 250 | Crop Production | 1/2 |
| RE 250 | Rural Economy | 1/2 |
| | Total | 2 1/2 |

| | | Management & Extension | Option | |
|---|---|---|---|---|
| | | | Animal | Crop |
| **YEAR III** | | | | |
| AC 301 | Soil and Fertilizers | 1/2 | --- | 1/2 |
| AC 302 | Advanced Soil Science | --- | --- | 1/2 |
| AC 303 | Animal Nutrition & Biochemistry | --- | 1 | --- |
| AE 301 | Farm Mechanization - Crops | 1/2 | --- | 1/2 |
| AE 302 | Farm Mechanization - Animals | --- | 1/2 | --- |
| AS 301 | Feeds and Feeding II | 1/2 | 1/2 | --- |
| AS 302 | Animal Breeding | --- | 1 | --- |
| AS 303 | Reproductive Physiology and A.I. | --- | 1/2 | --- |
| AS 304 | Dairy Management | 1/2 | 1/2 | 1/2 |
| AS 305* | Processing of Agricultural Products | 1 | 1 | 1 |
| AS 306 | Poultry Management | 1/2 | 1/2 | --- |

|  |  | Management | Option |  |
|---|---|---|---|---|
|  |  | & Extension | Animal | Crop |
| YEAR III (Continued) |  | 1/2 | 1/2 |  |
| CS 301 | Agronomy IV (Horticulture) | 1/2 | 1/2 | 1/2 |
| CS 302 | Agronomy V (Perennial Crops) | 1/2 | 1/2 | 1/2 |
| CS 303 | Crop Improvement | 1 | --- | 1 |
| CS 304 | Economic Botany and Crop Physiology | --- | --- | 1 |
| CS 305 | Plant Pathology | --- | --- | 1 |
| CS 306 | Crop Pests | --- | --- | 1 |
| RE 301 | Agricultural Production and Marketing Programs | 1 1/2 | 1 1/2 | 1 1/2 |
| RE 302 | Agricultural Program Implementation | 1 1/2 | --- | --- |
| RE 303 | Socio-Economic Surveys | 1/2 | --- | --- |
|  | Electives | 1 1/2 | 1 1/2 | 1 |
|  | Total | 10 1/2 | 10 1/2 | 10 1/2 |

Students in the third year will be required to select 1 to 1 1/2 course units from those not listed in their option as electives.

Course prefixes above represent the following departments:

| | |
|---|---|
| AC | Soil Science and Agricultural Chemistry |
| AE | Agricultural Engineering and Land Planning |
| CS | Crop Science and Production |
| AS | Animal Science and Production |
| RE | Rural Economy and Extension |

(iv) In addition to completing the above syllabus, students reading for the B.Sc. (Agriculture) will be required to:

(a) Conduct and write up a special project during the long vacation between the second and third year

(b) Learn practical skills during a seven week "fourth term", at present held during vacation periods

(c) Submit a farm management case study during the third year

(v) Brief descriptions of the courses offered are as follows:

FIRST YEAR

AC 101 Inorganic and Physical Chemistry (1 Course Unit)

Elementary quantitative chemistry. Acids, bases, buffers, and indicators. Osmotic pressure. Surface chemistry, including chromatography and surface tension. Colloids. Elementary crystal structure. Elementary electrochemistry. Radioactivity. Inter-atomic and inter-molecular forces. Review of the essential elements for plant and animal growth.

AC 102 Agricultural Chemistry (1 Course Unit)

Review of the important reaction types in organic chemistry. Chemistry of biologically important compounds, including carbohydrates, lipids, amino acids, proteins, and nucleic acids. Feeding stuff analysis. Reaction kinetics and an introduction of enzymology.

AC 103 Microbiology (1 Course Unit)

A study of bacteria, actinomycetes, fungi and lower algae. Elementary principles of the ecology physiology, and classification of micro-organisms important in agriculture.

AE 101 Agricultural Engineering (1 1/2 Course Units)

Engineering materials, machines and mechanisms in agriculture. Farm electricity. Design of simple machines and installations. Introduction to field machinery.

AS 101 Zoology (1 1/2 Course Units)

Introduction to Vertebrate Zoology; animal classification and anatomy. Animal reproduction, fertilization, implantation, ovulation, etc. The major Classes of Vertebrates: Fishes, fishery biology, fish culture, commercial fisheries; Amphibians and Reptiles, reproduction and anatomy, general classification; Birds, behavior, anatomy, nesting, physiology, classification of major Orders; Mammals, anatomy, reproduction, embryology, development, classification of major Orders, conservation.

Introduction to Invertebrate Zoology: Protozoa, classification of major Classes, anatomy reproduction, physiology, free-living and parasitic forms; Helminths, anatomy, reproduction and life cycle of Cestodes, Trematodes and Nematodes, parasitic forms, parasites of vertebrate animals, particularly humans and livestock, physiology, classification; Molluscs, anatomy and classification of major groups of Molluscs, snails, clams, mussels, reproduction, physiology; Arthropods; major groups, anatomy and classification, physiology.

CS 101 Introductory Botany (1 Course Unit)

Anatomy: Cell structure and basic cell types; synthesis of these into a study of basic plant structures and changes related to ageing.

Morphology: The cross structure of plants with special reference to the relationships between form and function. The concept of the plant as a unit, and modifications met under conditions of environmental stress. Taxonomy: A background survey of the plant kingdom and the importance of various groups. The Angiosperms (seed plants) and the importance of this group within agricultural importance. Reproductory mechanisms.

CS 102 Introductory Genetics (1/2 Course Unit)

Simple Mendelian genetics, other forms of gene action; continuous and discontinuous variation; genotypes and phenotypes; genes, allelomorphs and loci; different types of inheritance of two pairs of alleles; measurement of linkage; gene frequency in populations; the genome concept; polyploidy; mitosis and meiosis.

CS 103 Plant Physiology (1 Course Unit)

The composition of the plant body. Uptake of water; imbibition, osmosis, suction pressure. Transpiration, regulation of water loss, transpirational pull. Mineral requirements of plants; mechanism of salt uptake, ion antagonism and synergism, the physiological effect of salt types. Photosynthesis; the experimental evidence for the physiology and chemistry of the process, factors affecting photosynthesis, subsequent metabolism of carbohydrates. Respiration; an outline of the chemistry of aerobic respiration, energy transfer mechanisms, derivation of major plant body components. Nitrogen metabolism; nitrate reduction, amino acids, nucleic acids, protein formation Physiology of growth and development; the fundamental growth processes, growth substances (also their action in plant movements), factors affecting growth.

CS 104 Agronomy I - Principles of Agronomy (1 Course Unit)

Biological and types of economic yield; their interrelations; yield and radiant energy fixation. The crop as production unit; density-yield functions; radiant energy interception and utilization; crop growth rates and their parameters; crop development cycles and partition of assimilates. The influence of environment factors upon yield and its parameters; single factor-yield functions and their use in agriculture; factor interaction: factor regimes, their influence upon agronomic potential and their modification in field practice.

Introduction to meteorology and climatology as related to East African Agriculture.

CS 105 Ecology (1/2 Course Unit)

An introductory course on the concepts of ecology and their relevance to land utilization, covering both botanical and zoological aspects. Includes an introduction to the basic concepts of habitat, ecosystem and of productivity. Locally, important ecosystems such as swamps, lakes, game reserves, etc., are used to illustrate these concepts.

CS 106 Entomology (1/2 Course Unit)

Classification, anatomy, life cycles of insects; important forms, plants and animal parasites, ecology, distribution.

RE 101 Introductory to East African Agriculture (1 Course Unit)

General Agriculture: Agriculture in the World and East Africa. Its place and importance in the life, economy and development of East Africa. Factors which influence and determine patterns of land use and farming development.

Agricultural Systems: Principle types of agriculture in East Africa, their main characteristics and problems in their development. Empirical data on farm situations.

RE 102 Agricultural Economics (1 1/2 Course Units)

a. Introduction to Development Economics: National Income Accounting and Planning; Stages of Development, Alternative Development Strategies.

b. Agriculture and Economic Growth: The role of the agricultural sector in economic development; agricultural planning and performance in East Africa.

c. Price Theory: With particular reference to agricultural situations. Price formation under perfect and imperfect competition; price fluctuations and price differentials. Analysis of market efficiency. Methods of intervention by Government.

SECOND YEAR

AC 201 Biochemistry (1 Course Unit)

Enzymology; metabolism of carbohydrates, lipids, amino acids, proteins and nucleic acids; digestion; metabolic control mechanisms, energy relationships; mineral and vitamin metabolism; digestions; plant biochemistry; selective toxicity; introduction to soil biochemistry.

AC 202 Geology and Soil Formation (1/2 Course Unit)

Elementary geology, rock minerals and weathering; elementary geomorphology and the evolution of East African landscapes; soil formation and the development of soil profiles; elementary account of different soil types.

AC 203 Soil Physics (1/2 Course Unit)

Soil texture and structure; pore space, soil, air and water energy relationships and the hydrologic cycle; properties of clays; other physical properties of soils, including color, temperature, erodibility and tilth.

AC 204 Soil Fertility (1 Course Unit)

Basic principles of soil chemistry and soil microbiology, including soil colloids, ion exchange, soil reaction, the main nutrient elements and their microbial transformations. Nutrition of plants, soil fertility and soil amendments.

AC 250 Soil Science Excursion (1/2 Course Unit)

A one-week excursion through selected areas of Uganda to study and sample soil profiles. Centers of agricultural interest in the regions are also visited during the excursion.

AE 201 Soil/Water Engineering and Structures (1 Course Unit)

Principles and techniques of soil and water conservation and drainage, road and dam construction, hydraulics, pumps and irrigation. Farm structures.

AE 202 Farm Mechanization (1 Course Unit)

Tractors and field machinery, their characteristics, choice and use; ox cultivation, small tractors, spraying and dusting. Crop harvesting, processing and preservation.

AE 250 Agricultural Engineering and Surveying - Practical Training (1/2 Course Unit)

Use of survey equipment in measurement of distance, area laying out contour lines, graded lines, calculations of slope, differential leveling, laying out angles, compass traverse survey. Plane table mapping.

AS 201 Feeds and Feeding (1 Course Unit)

Feeding standards and classification of feeds found in East Africa. Factors affecting the utilization of feeds by livestock. The utilization of pastures and feed conservation in the form of silage and hay.

AS 202 Animal Physiology (1/2 Course Unit)

Principles of animal physiology as it refers to farm animal structure and function.

AC 203 Livestock Management (1 Course Unit)

The management of beef cattle, sheep, goats and swine. Physiological and environmental interactions affecting the management and production of various types of livestock in East Africa.

AS 250 Animal Production - Practical Training (1/2 Course Unit)

The work will include practical operations with the poultry flock, the piggery and the dairy herd. Emphasis will be given to the development of an appreciation for the day-to-day operations and the importance of these to overall management.

CS 201 Agronomy II (Annual Crops) (1 Course Unit

Types of annual crops and their importance in East Africa; distribution of annual crops in relation to East African environments; application of agronomic principles in the production of grain, pulse, oil seed, root and industrial crops within the East African environments. Annual crop enterprise economics.

CS 202 Agronomy III (Pasture Agronomy) (1/2 Course Unit)

Grassland ecology; range types and their value; the characteristics of East African grass and legume species; principles of grassland production; range and grassland management and improvement; sown grassland, their establishment, management and utilization; conservation of grassland products; measurements of grassland productivity and the animal--grassland complex.

CS 203 Principles of Crop Protection (1 Course Unit)

Damage caused to crops by weeds, pathogens and pests; population dynamics; cost/potential benefit value in relation to control; principles of control.

The major diseases, weeds, and pests of East African crops and their control; stored products diseases and pests, and their control. Principles and practice of field use of chemicals for crop protection.

CS 204 Applied Statistics (1 Course Unit

Use of statistics in agricultural experimentation; normal distribution and its parameters; standard error of a difference; use of the "t" test. Calculation of linear regressions and correlation coefficients, data transformation. Analysis of variance for randomized blocks, latin squares, simple factorials and split plots. Field techniques and factors determining the choice of experimental design.

CS 250 Crop Production - Practical Training (1/2 Course Unit)

Seedbed preparation and sowing. Methods of vegetative propagation. Fertilizer use and application. Plant protection, use of sprays, etc. Harvesting of crops. Experimental techniques, laying out of plots, observations within plots, yield measurement and components of yields.

RE 201 Production Economics and Farm Management (1 1/2 Course Units)

a. Production Economics: Rational decision making in communal and individual forms of agricultural organization. Time, uncertainty and risk in agricultural production. Economic principles of land tenure, credit, conservation, mechanization, etc., at the individual farm level. Investment analysis.

b. Farm Management Economics: Management accounts and farm planning; gross margin; partial and whole farm budgeting; program planning and linear programming. Credit appraisal.

RE 202 Agricultural Extension and Rural Sociology (1 1/2 Course Units)

a. Agricultural Extension: The principles of extension. Program planning. Extension methods. Preparation of visual aids. Evaluation.

b. Rural Sociology: Sociological analysis of traditional society and social change. Social factors affecting nutritional welfare development planning and specific measures of induced change.

RE 250 Rural Economy - Practical Training (1/2 Course Unit)

a. Agricultural Extension: Preparation of demonstration materials; organization and presentation of method demonstrations.

b. Farm Accounts: Construction and analysis of farm accounts; profit and loss; balance sheet; management accounts.

## THIRD YEAR

AC 301 Soils and Fertilizers (1/2 Course Unit)

Properties and classification of East African soils. Soil-plant relationships and soil fertility in East Africa. Outline of the manufacture and properties of different fertilizers.

AC 302 Advanced Soil Science (1/2 Course Unit)

More detailed soil physics, chemistry and microbiology, including a fuller treatment of soil water, clay minerals, availability of nutrients and soil organic matter.

AC 303 Animal Nutrition and Biochemistry (1 Course Unit)

Biochemistry of specialized tissues. Digestibility, food intake; assessment of the energy and protein values of feeding stuffs; animal feed requirements. Vitamins and minerals. Hormones and antibotics. Human nutrition.

AE 301 Farm Mechanization (Crops) (1/2 Course Unit)

Farm planning principles and practice. Mechanized crop production. Rural mechanical aids.

AE 302 Farm Mechanization (Animals) (1/2 Course Unit)

Machinery in livestock production and processing. Dairy equipment and livestock buildings.

AS 301 Feeds and Feeding II (1/2 Course Unit)

The feeding of poultry and swine.

AS 302 Animal Breeding (1 Course Unit)

The role of genetics and breeding in the improvement of East African livestock; heredity and environment; systems of selection; standards of selection; standards of evaluation for livestock improvement; population genetics.

AS 303 Reproductive Physiology and Artificial Insemination (1/2 Course Unit)

Livestock fertility and artificial insemination--the practical problems which are important in the use of artificial insemination.

AS 304 Dairy Management (1/2 Course Unit)

Factors which affect the successful management of a dairy herd. The growth and development of animals, economic factors, milk secretion, advanced problems in management under East African conditions.

AS 305 Food Technology and Agricultural Processing (1 Course Unit)

The purpose and value of processing. Physical, biochemical and microbiological aspects of the extraction, conversion and preservation of agricultural raw materials.

Quality, cost and health aspects of food processing, dairy manufacturing, poultry processing, meat technology, vegetable and fruit preservation.

Production processes for cocoa, cereal grain conversions, soft and hard fibers, vegetable proteins, true oils and fats, essential oils, drugs of plant origin.

AS 306 Poultry Management (1/2 Course Unit)

Principles of management and production of poultry and poultry products in East Africa. Hatching, growing and maintenance of meat and egg producing flocks in the various species of poultry. The effects of environment on systems of poultry production.

AS 307 Animal Health and Hygiene (1 Course Unit)

Health and disease as it affects farm animals. Animal parasitology. Management problems for disease control.

CS 301 Agronomy IV (Horticulture) (1/2 Course Unit)

The importance of vegetables, fruits and ornamentals in developing countries with particular reference to East Africa. Methods of propagation, use of fertilizers, irrigation and other cultural practices including the use of plant growing structures. Economic assessment of horticultural enterprises.

CS 302 Agronomy V (Perennial Crops) (1/2 Course Unit)

Types of perennial crops and their economic importance in East Africa. Distribution of perennial crops in relation to East African environments. Application of agronomic principles to the production of coffee, sisal, tea, pyrethrum, cloves, sugarcane, pineapples, coconuts, cocoa, citrus and other fruit crops within East African environments. Propagation, pruning and grafting techniques as applied to these crops. Perennial crop enterprise economics.

CS 303 Crop Improvement (1 Course Unit)

Natural breeding systems in plants, genetic nature of wild and cultivated populations; phenotypic and genotypic variation; selection criteria in different crops; breeding systems used in annual and perennial crop plant improvement; gene pools, composite populations; breeding for disease resistance, pest resistance and positive physiological characteristics. Testing of new material.

CS 304 Economic Botany and Crop Physiology (1 Course Unit)

Domestication of plants for food, fibers, oils, building materials, drugs, spices, etc.; major botanical orders of economic significance; polyploidy and crops, the genome concept; crop classification at a sub-specific level; crop morphology and economic adaptation. Crop-water relations; root development, loss of water from green vegetation, water loss under "oasis conditions." Mineral nutrition of plants; deficiency symptoms, foliar absorption of minerals, plant analysis. Factors affecting dry matter production of a crop; light utilization. Carbon dioxide; fluxes in plant stands, "soil respiration," plant responses to above normal concentrations. Growth analysis. Plant growth substances in relation to uses in agriculture. Day length and temperature effects on growth and reproduction. Physiology of seeds in relation to storage, viability and germination. Post-harvest physiology of fruits in relation to storage conditions and storage life, distribution and marketing conditions.

CS 305 Plant Pathology (1 Course Unit)

Host-parasite relations; organisms which cause disease in plants. Pathogen and environmental factors associated with infection and establishment. Host resistance and susceptibility. Plant disease symptoms. Epidemology and control; inoculum potential and dispersal. Environmental and cultural factors affecting growth of plant disease epidemics. Quarantines. Fungicides and fungicidal mechanisms. Breeding for resistance. Cultural practices and biological control. Specific diseases; diseases of important world crops and their control. Diseases of important East African crops and their control. Special aspects relating to seed-borne and soil-borne diseases.

CS 306 Plant Pests (1 Course Unit)

Concept of population; estimation of populations; insect numbers; pest damage, pest outbreaks; economics of pest attack and control; forecasting pest attacks. Methods and principles of pest control. Pest of timber, cotton, coffee and cereals in East Africa. Nematode plant pests. Bird and mammal pests. Pests of domestic animals and man and their relevance to East African agriculture.

RE 301 Agricultural Production and Marketing (1 1/2 Course Units)

a. Agricultural Production Policy: The economic analysis of direct and indirect investment of public funds in the agricultural sectors of East Africa; the "transformation" and "improvement" approaches to agricultural development; agricultural employment and income policy.

b. Agricultural Marketing Policy: The economic analysis of agricultural price, marketing and taxation policies with particular reference to East Africa. International trade and commodity markets.

RE 302 Agricultural Program Implementation (1 1/2 Course Units)

Administrative, social and economic aspects of agricultural development administration. Introduction to project and district-level agricultural planning and plan implementation. Relevant principles of business and public administration and personnel management.

RE 303 Socio-Economic Surveys (1 1/2 Course Unit)

Types of field surveys and investigations; objectives, costs and uses. Designing a research project. Sample designs and methods. Questionnaire design and testing; interview techniques; field measurement techniques; method study and work measurement. Analysis techniques. Literature research. Photographic and representational methods. Data presentation and report design.

## FACULTY OF AGRICULTURE

## SCHEME OF EXAMINATIONS FOR THE BACHELOR OF SCIENCE IN AGRICULTURE

Examinations for the Bachelor of Science in Agriculture will be in two stages:

1. Course unit examinations during the first year; a satisfactory performance which will qualify a student to enter the second year

2. Final examinations held at the end of the second and third years which will decide both whether a degree is awarded and the classification of the degree.

### I. First Year Course Unit Examinations

A. All first year course unit examinations will be internal faculty examinations. The questions will be set and graded by the lecturer(s) responsible for the course. They will include factual, problem solving and integrative types of questions. They may also test the student's practical ability.

B. Up to one-third of the marks awarded for any course unit may be based on continuous assessment.

C. Course units will be examined as soon as possible after the unit has been completed.

D. Course unit examinations will be of 1-hour duration for a 1/2 unit, 2 hours for a full unit and 3-hours duration for a 1 1/2 unit course.

E. Course grades will be calculated as follows:

| | |
|---|---|
| Excellent | 5 |
| Very Good | 4 |
| Good | 3 |
| Fair | 2 |
| Poor (compensable) (pass) | 1 |
| Fail | 0 |

F. Aggregate course grades will be calculated by multiplying the course grade by the course unit weighing and adding the products.

G. A student must obtain an aggregate course grade of 26 or more (based on 13 course units) to be considered for entry into the second year. If the student's aggregate course grade is less than 26, he shall be discontinued but may be reinstated on the recommendation of the Faculty Board.

H. A student who obtains an aggregate course grade of 26 or more will normally be required to resit all failed courses, although a student with an aggregate course grade of 28 or more will be permitted a failure in one course.

I. A student who is reexamined in a failed course should receive a grade of 1 or more before being permitted to commence the second year. A student who is referred in 2 or more courses and is able to raise his aggregate course grade to 28 or more will be permitted a failure in one course.

J. A student who does not pass his referred examination, or who does not meet the requirement in 'I' above, will normally be asked to repeat the year.

K. Referred examinations will be held before the beginning of the first term of the second year

### II. Final Examinations for the B.Sc. (Agriculture)

A. The final examinations in Agriculture will be composed of the following elements.

1. Written final papers taken at the end of the second or third years

2. Continuous assessment

3. A special project conducted in the long vacation between the second and third year

4. An assessment of a farm management case study conducted during the third year

5. A satisfactory report on performance in practical skills acquired during the second year

B. Regulations governing the final examination include the following:

1. At the end of the second year, students will sit three-hour final papers as follows:

| | |
|---|---|
| Soil Science and Biochemistry | 2 papers |
| Agricultural Engineering | 1 paper |

2. At the end of the third year, students will sit three-hour final papers as follows:

| | Management & Extension Option | Animal Option | Crop Option |
|---|---|---|---|
| Animal Science and Production | 2 | 4 | 2 |
| Crop Science and Production | 3 | 2 | 4 |
| Rural Economics and Extension | 3 | 2 | 2 |

AC 301, AC 302, AE 301 and CS 204 will be examined in Crop Production papers.

AC 303 and AE 302 will be examined in Animal Production papers.

3. Continuous assessment, based on unit examinations, assessment of practicals, essays, seminars, etc., will count for one-third of the possible marks in all final examination papers. At the termination of each course unit, the lecturer(s) responsible for the unit will submit, through their Head of Department, an assessment of the student's performance in that unit to the Faculty Office. This assessment will be based on the same grading standards as used in the final papers, i.e.:

| | |
|---|---|
| Excellent | 70% + |
| Very Good | 60% - 69.9% |
| Good | 50% - 59.9% |
| Pass | 40% - 49.9% |
| Fail | Below 40% |

4. The final paper mark will be from a total of 150 marks, of which a possible 100 marks will be allocated to the final paper and a possible 50 allocated to continuous assessment of the courses making up that paper. The continuous assessment mark will be the weighed average of the course making up that paper.

5. A student must safisfy the examiners in all subjects and in the special project plus case study before being awarded a degree.

6. The pass-mark for a subject will be an average of 40% or 60% marks of the paper making up that subject.

7. An average of below 35% in any subject will be considered a clear failure in that subject.

8. Compensation will be allowed between subjects for one subject only, provided the mark in that subject is 35% or above, and that a formula of two marks above 40% in other subjects for each mark compensated is followed.

9. A student may be referred in one subject only, either at the end of the second or third year.

10. External Examiners will check all papers examined and may also, on request, check any unit examinations used for the purposes of continuous assessment.

11. The final paper mark should be agreed to by both External and Internal Examiners although the mark of the External Examiner will normally prevail. Should there be serious disagreement, then Faculty Board will be asked to adjudicate.

12. Classification of the degree will be based as follows:

| | |
|---|---|
| Best 9 of all papers at 150 possible marks each | 1350 |
| Special project and case study | 100 |
| Assessment of elective courses | 50 |
| | 1500 |

The total number of marks will be divided by 15 and the degree classified as follows:

| | |
|---|---|
| First Class | 70% + |
| Upper Second | 60% - 69.9% |
| Lower Second | 50% - 59.9% |
| Pass | 40% - 49.9% |

Faculty Board may, under special circumstances, recommend that a student obtaining marks of 65 - 69.9%, 55 - 59.9% or 45 - 49.9% be awarded a first, upper second or lower second degree, respectively.

13. A student who repeats his final year will, if successful, be normally awarded an unclassified degree.

## Appendix N

## PROPOSED SYLLABUS
## RURAL ECONOMY AND EXTENSION DEPARTMENT
## MAKERERE UNIVERSITY

This Department would like to make some changes in its courses and to make a few shifts in the timing of course offerings. The first part of the paper will present the present course titles and descriptions as well as the proposed changes. The reasons for proposed changes will be presented later in the paper.

### YEAR I - PRESENT COURSE OFFERINGS

RE 101 Introduction to East African Agriculture (1/2 Course Unit)

General Agriculture; Agriculture in the World and East Africa. Its place and importance in the life, economy and development of East Africa. Factors which influence and determine patterns of land use and farming development. Agricultural systems; principal types of agriculture in East Africa, their main characteristics and problems in their development. Empirical data on farm situations.

RE 102 Agricultural Economics (1 1/2 Course Units)

(a) Introduction to Development Economics: National Income Accounting and Planning; Stages of Development; Alternative Development Strategies.

(b) Agriculture and Economic Growth: The role of the agricultural sector in economic development; agricultural planning and performance in East Africa.

(c) Price Theory: With particular reference to agricultural situations. Price formation under perfect and imperfect competition; Price fluctuations and price differentials. Analysis of market efficiency. Methods of intervention by Government.

RE 103 Introduction to Statistics (1/2 Course Unit)

Basic concepts of statistics, frequency distributions, presentation of raw data, measures of central tendency, measures of dispersion, elementary sampling theories and time series analysis.

Total Course Units - 2 1/2

## YEAR I - PROPOSED COURSE OFFERINGS

RE 102 Introduction to Agricultural Economics (2 Course Units)

(Proposed to be taught second and third terms) Second term to include Agriculture and Forestry students. Third term for Agricultural students only.

An introductory course to agricultural economics which emphasizes breadth rather than depth. Includes study of economy of E. A. measurements of production and national income through the price system; the theory of the firm; money and aggregate demand; marketing of agricultural products; principal types of agriculture in East Africa; international trade and payments; agricultural development; development planning; agricultural policies in East Africa.

Note: This course will include the present RE 101.

RE 103 Agricultural Statistics (1/2 Course Unit)

Same course as is presently given.

Total Course Units - 2 1/2

## YEAR II - PRESENT COURSE OFFERINGS

RE 201 Production Economics and Farm Management (1 1/2 Course Units)

(a) Production Economics: Rational decision making in communal and individual forms of agricultural production. Economic principles of land tenure, credit, conservation, mechanization, etc., at the individual farm level. Investment analysis.

(b) Farm Management Economics: Management accounts and farm planning; gross margin; partial and whole farm budgeting program planning and linear programming. Credit appraisal.

RE 202 Agricultural Extension and Rural Sociology (1 1/2 Course Units)

(a) Agricultural Extension: The principles of extension. Program planning. Extension methods. Preparation of visual aids. Evaluation.

(b) Rural Sociology: Sociological analysis of traditional society and social change. Social factors affecting nutritional welfare development planning and specific measures of induced changes.

RE 250 Rural Economy--Practical Training (1/2 Course Unit)

(a) Agricultural Extension: Preparation of demonstration materials; organization and presentation of Method Demonstrations.

(b) Farm Accounts: Construction and analysis of farm accounts; profit and loss; balance sheet; management accounts.

Total Course Units - 3 1/2

## YEAR II - PROPOSED COURSE OFFERINGS

RE 201 Production Economics and Farm Management (2 Course Units)

Same course as is presently given but will add the enterprise and livestock economics formerly incorporated in the Crop and Animal Science courses.

RE 202 Agricultural Extension and Rural Sociology (1 1/2 Course Units)

Same course as present one.

RE ? Social Science Research Methodology (1/2 Course Unit)

Same course that was formerly RE 303. Types of field surveys and investigations; objectives, costs and uses. Designing a research project. Sample designs and methods. Questionnaire design and testing; interview techniques; method study and work measurement. Analysis techniques. Literature research. Photographic and representational methods. Data presentation and report design.

Total Course Units - 4

## YEAR III - PRESENT COURSE OFFERINGS

RE 301 Agricultural Production and Marketing (1 1/2 Course Units)

(a) Agricultural Production Policy: The economic analysis of direct and indirect investment of public funds in the agricultural sectors of East Africa; the 'transformation' and improvement approaches to agricultural development; agricultural employment and income policy.

(b) Agricultural Marketing Policy: The economic analysis of agricultural price, marketing and taxation policies with particular reference to East Africa. International trade and commodity.

RE 302 Agricultural Program Implementation (1 1/2 Course Units)

Administrative, social and economic aspects of agricultural development administration. Introduction to project and district-level agricultural planning and plan implementation. Relevant principles of business and public administration and personnel management.

RE 303 Socio-Economic Surveys (1/2 Course Units)

Types of field surveys and investigations; objectives, costs and uses. Designing a research project. Sample designs and methods. Questionnaire design and testing; interview techniques; field measurement techniques, method study and work measurement. Analysis techniques. Literature research. Photographic and representational methods. Data presentation and report design.

Total Course Units - 3 1/2

## YEAR III - PROPOSED COURSE OFFERINGS

### Agricultural Development (1 Course Unit)

Key role of agriculture in development; historical transformation from peasant to modern agriculture; role of nutrition, population, labor, land, capital, research, education, economic incentives, markets, marketing institutions, credit, cooperatives and external aid to agricultural development; East African government policies toward agricultural development; world agricultural systems.

### Marketing of Agricultural Products (1 Course Unit)

Production and distribution of food in East Africa; traditional markets; price marking forces in the market; major markets and channels for export crops; demand and supply conditions and elasticities for major crops; international marketing agreements, export potential of various crops, marketing boards; marketing margins, evaluation of local marketing systems.

### Agricultural Administration and Plan Implementation (1 Course Unit)

Democracy and public administration; responsibility of public agencies in carrying out public will; policy formulation in Uganda; organizational aspects of agricultural administration; colonial administration; development administration; personnel management; plan implementation programs and projects in Uganda; evaluation of plan implementation.

Agricultural Cooperatives and Credit (1 Course Unit)

Philosophy of cooperation; cooperative principles; world-wide cooperative developments; cooperatives in socialist and nonsocialist economics; types of cooperatives, cooperative performance; cooperative experience in East Africa; credit savings and investment in a peasant society; role of credit in agricultural development; credit institutions in East Africa and their performance.

Total Course Units - 4

The present syllabus for the Department of Rural Economy and Extension contains 9 1/2 course units. The proposed syllabus contains 10 1/2 course units. Looking at it, at first glance, the suggestion seems that the Department is asking for an increase of a full course unit in its new syllabus.

The actual fact is that over a half course unit which the Department formerly offered as lectures combined in other departments do not appear in the syllabus. In the 1968-69 and the 1969-70 academic year, there were 5 lectures in livestock economics offered to second year students plus 10 lectures in livestock economics to third year students. There were a further 10 lectures in coop-enterprise economics offered to third year crop science students. Because of the awkwardness of this kind of interspersed teaching it was never recognized as a half course unit equivalent.

During the 1970-71 academic year the entire group of lectures were ignored, even though we asked to teach some of them in their former setting. We feel that the economic aspects of livestock and crop production are important and should be thought by economist as part of a separate course in the Department. Our opinion is that it is no more unfair for economist to teach their speciality than for other disciplines to request the same. Presumably it would be more desirable to have an economist to teach economics and animal or crop scientists teach their subjects than to have a reverse situation.

## Proposals on a Yearly Basis

The proposal to combine RE 101 and 102 into one course is made because we feel there is a need for students to get a basic introduction to economic theory before they are expected to understand the application of their concepts. The former RE 102 was too heavily loaded with planning and economic development which was the basis for a large amount of student criticism of this course. The development part of the syllabus has been suggested to be put in the third year when students have had a larger basis of technical and economic knowledge to build upon. They should then be in a better position to understand both the problems and interrelationships between technical and economic concepts in economic development.

Year II has only a few suggested changes. The enterprise and livestock economics is suggested to be added to the Production Economics and Farm Management course. This seems to be a logical place for it because it follows the basic production theory and the more applied and general Farm Management application of production theory. This section will provide the more specific application of production and management economics to crop and animal production.

RE 303, formerly offered in the third year, has been suggested to be put forward to the second year. This seems more logical in the sequence of the students' work because it teaches research methodology to students before they begin their special projects.

The changes proposed for the Year III courses include a disaggregation of 1 1/2 unit courses into one (1) unit courses. This will provide opportunity to teach the material in more depth and in more compact units.

Agricultural Development would become a separate course and would emphasize the role of agriculture in economic development. It is suggested that more theory of development be offered to provide students with some basic concepts to use in analysis. The role of planning and discussion of plans so heavily emphasized in the earlier first year course was criticized by students because they felt a lack of knowledge of theoretical concepts. This course will emphasize the theory and problems of agriculture development and the role of agriculture in the future development of the East African economies.

Agricultural Marketing will place more emphasis on the role of the market in agricultural development and management. This course is suggested to be reduced from a 1 1/2 unit to a one (1) unit course. The main reason for this was to allow greater emphasis on cooperatives and farm credit in the new one (1) unit course being proposed which is in these specific areas.

The major crops and the largest foreign exchange earners (coffee and cotton) are marketed entirely through cooperatives. Students who will work in agriculture should have a knowledge of cooperative theory, philosophy and principles in this order to have a better understanding of these institutions. This course should incorporate these concepts as well as emphasize the role of cooperation in Uganda's agriculture.

Agricultural credit will be included in this course because students have gotten only a small amount of training in this area in the past. This seems a logical place to put this section because the national trend in Uganda (as in most developing countries) is to provide agricultural credit through cooperatives.

Agricultural Administration and Plan Implementation is proposed as a one (1) course unit subject. This will provide an opportunity to present to students the role of public institutions and the role of the administration in them. These public institutions are responsible for implementation of the development plans and students should have some knowledge of this role. The importance of this course is great because many of the graduates from this Faculty will be involved in administration, at some level, in their future career.

The Department is asking for 4 course units in the third year instead of the former 3 1/2 units. This is a request for a total increase of 1/2 course unit in the overall syllabus for this Department. The argument for the other 1/2 unit was presented earlier in this paper. We hope the Committee can see the need for these proposed changes and will accept our proposal.

Victor F. Amann
Senior Lecturer

## Appendix O

## REGULATIONS FOR THE DEGREES OF MASTER OF SCIENCE IN AGRICULTURE AND MASTER OF SCIENCE IN FORESTRY

## FACULTY OF AGRICULTURE
## MAKERERE UNIVERSITY

M.Sc. Ag. - 1 The following shall be eligible for the degree of Master of Science in Agriculture and the Master of Science in Forestry:

(a) Any Bachelor of Arts or Bachelor of Science or Bachelor of Science in Agriculture or Bachelor of Veterinary Science or Bachelor of Science in Forestry of the University for not less than 18 months after satisfying the requirements for that degree

(b) Any graduate of another recognized University who has been admitted to the status of Bachelor of Arts or Bachelor of Science or Bachelor of Science in Agriculture or Bachelor of Veterinary Science or Bachelor of Science in Forestry in the University, who has been a registered student of a constituent college of the University for not less than 18 months after admission to the status of that degree and who has, within that period, attended at a constituent college of the University and/or at some other place or places approved by the Senate for the purpose for at least 18 months.

Ag. - 2 The Faculty of Agriculture offers two types of M.Sc. degrees:

Plan A: M.Sc. (Agriculture) only
Consisting of a major component of course work supplemented with a research project.

Plan B: M.Sc. (Agriculture) or M.Sc. (Forestry)
Consisting of small component of course work plus a major research project.

Before registering, an intending candidate shall indicate which of these two types of programs he wishes to pursue.

## REGULATIONS FOR PLAN A - M.SC. (AGRICULTURE)

Ag. 3 The Course Work Portion of the Plan A M.Sc. (Agriculture) shall consist of satisfactory completion of a minimum of eight post-graduate course units (400 series), described below and at least one academic year of residence at Makerere. At least one of the required units must be from the "Common Course" (CC) offerings. Candidates with a first degree other than the Makerere B.Sc. (Agriculture) may be required to take one or more undergraduate courses in addition to the minimum requirement of "400" series courses. The Course Work Portion will be considered as qualifying the candidates to take the final examination. Satisfactory completion of the required course units will be based on internal examinations given during and/or at the end of each of the respective courses. The results and papers of these examinations shall be available on request to the external examiner selected for the final examination. Before commencing the research for the thesis the candidate for the degree shall submit, for the approval of the Faculty Board an outline of the special study or research which he proposes to pursue. The authorities concerned may, at their discretion, decline to approve the proposal (a) if, in their opinion, it is unsuitable in itself, or (b) if it cannot profitably be studied under the supervision of the University or supervision outside the University which is acceptable to Senate, or (c) if the conditions under which the candidate proposes to work are unsatisfactory.

Ag. 4 The Final Examination of the Plan A M.Sc. (Agriculture) shall consist of satisfactory completion of a research project and the final examination. The final examination shall be a University examination consisting of a dissertation or a dissertation and one or more written papers.

NOTE: The examiners should be made aware of the fact that the major portion of this M.Sc. degree is the course work portion so that the expectations for the dissertation will be of a different magnitude than for the Plan B research dissertation.

Ag. 5 In the event that a student finds it necessary to discontinue his registration after completion of the course work portion but before the completion of the final examination of the Plan A M.Sc. (Agriculture) a certificate indicating satisfactory completion of the course work portion can be awarded to him by the Faculty.

Ag. 6 The course work portion may be waived by Senate on recommendation of Faculty Board for candidates who have completed equivalent postgraduate course work and residence at another University without having received any academic award. In such cases, the registration requirement for research and final examination will be a minimum of one year.

## REGULATIONS FOR PLAN B - M.SC. (AGRICULTURE) OR M.SC. (FORESTRY)

Ag. 7 The Course Work Portion of the Plan B, M.Sc. (Agriculture) or M.Sc. (Forestry) shall consist of satisfactory completion of a minimum of three postgraduate course units (400 series) described below. At least one of these must be chosen from the "Common Course" (CC) offerings. For candidates who are required to take CC 402 in addition to CC 401 the minimum course units for this portion is four.

Candidates with a first degree other than the Makerere B.Sc. (Agriculture) may be required to take one or more undergraduate courses in addition to the minimum requirement of "400" series courses.

The course work will be considered as qualifying the candidate to advance to the final examination. Satisfactory completion of the required course units will be based on internal examinations given during and/or at the end of each of the respective courses. The results and papers of these examinations shall be available to the external examiner selected for the final examination.

Ag. 8 In addition to the small course work portion the Plan B, M.Sc. (Agriculture) or M.Sc. (Forestry) shall consist of satisfactory completion of a research project and the final examination. The final examination shall be a University examination consisting of a dissertation or a dissertation and one or more written papers.

Ag. 9 No certification of completion of the course work portion will be provided.

Ag. 10 The course work portion may be waived by Senate on recommendation of Faculty Board for candidates who have completed equivalent postgraduate course work and residence at another University.

Ag. 11 Before registration, an intending candidate for the degree shall submit, for the approval of the Faculty Board, an outline of the special study or research which he proposes to pursue. The authorities concerned may, at their discretion, decline to approve the proposal (a) if, in their opinion, it is unsuitable in itself, or (b) if it cannot profitably be studied under the supervision of the University or supervision outside University which is acceptable to the Senate, or (c) if the conditions under which the candidate proposes to work are unsatisfact

## GENERAL REGULATIONS FOR BOTH TYPES OF M.SC. (AGRICULTURE OR M.SC. (FORESTRY)

Ag. 12 A candidate for the degree shall undertake advanced study and/or research under the guidance of a supervisor or supervisors appointed by the Academic Board of his constituent college and approved by the Senate.

Ag. 13 Candidates who spend the major part of their study period away from one of the constituent colleges will be expected to maintain a close connection with the Faculty of Agriculture which has provided or appointed the supervisor or supervisors.

Ag. 14 The examiners may require a candidate for the degree to present himself for viva voce examination in addition to such other examinations as may be prescribed.

Ag. 15. At least six months before the dissertation is to be presented, a candidate shall give notice in writing to the Registrar of the University submitting at the same time the proposed title and an outline of the plan and general scope of the work.

Ag. 16. A dissertation submitted for the degree must be satisfactory as regards form and literary presentation; it must also include a full bibliography of the material, whether published or otherwise, used in its preparation.

Ag. 17 A dissertation accepted by the University and subsequently published, in whatever form, shall bear the inscription "dissertation approved for the degree of Master of Science in Agriculture or Master of Science in Forestry in the University of East Africa."

Ag. 18 Every dissertation submitted for the degree must be accompanied by a declaration to the satisfaction of the Senate stating that it has not been submitted for a degree in any other University.

Ag. 19 In the final examinations no candidate may present himself for examination in any subject more than once except for special reasons to be approved by the Senate in each particular case. It shall, however, be competent for the examiners to recommend and for the Senate to approve, that a dissertation be referred back to the candidate for revision or extension.

Ag. 20 Satisfactory performance of resident M.Sc. students includes attendance at Faculty Research Colloquia and such seminars as may be set up in relevant fields of study.

Ag. 21 The candidate shall also be subject to such supplementary regulations as may from time to time be determined by the Board of a Faculty of Agriculture as approved by the Academic Board of the constituent college.

Note: The period of 18 months mentioned in Regulation Ag. 1 is a minimum period stipulated by the University. Prospective candidates for the degree of Master of Science are advised that it will rarely be possible to complete the requirements for the degree within the time.

## GENERAL INFORMATION ON POSTGRADUATE COURSES FOR THE M.SC. (AGRICULTURE AND M.SC. (FORESTRY)

Ag. 22 The course units in either degree may be spread over two academic years or, where necessary, may be concentrated into the first year. The major or minor types of research projects may be similarly spread over two academic years according to the dictates of seasonal or other factors.

Ag. 23 The course work offered within each degree will be of two types:

(a) Formal courses involving lectures, seminars, laboratory and/or field practical work together with set reading

(b) Programmed self study course involving sequential reading lists where the student will meet the lecturer at intervals for discussion and/or paper reading seminars; laboratory and/or field practical work may also be required.

Ag. 24 The course units will in some cases cover subject areas not previously taken in undergraduate courses; in other cases they will be designed to study at a greater depth subject matter already appearing in the undergraduate courses.

Ag. 25 As Type "a" course units will normally need a minimum of four to five students before they are mounted each will have a parallel Type "b" unit for use where student numbers fall below the minimum. There will also be Type "b" course units which are not alternatives to Type "a". The courses will be numbered within a 400 series in which each "formal" course has a programmed self study course as an alternative under the same course unit number. The non-alternative Type "b" units will also be in the 400 series.

Ag. 26 Course units of each of the two types will contain 35 Lecture-Equivalents.

Ag. 27 Guidance as to choice of course units will be in consultation with the students supervisor; the final choice will be subject to the approval of the Postgraduate Studies Board.

## ADVANCED COURSE UNITS OFFERED IN THE FACULTY OF AGRICULTURE

The designation of course units by Department is as below:

CC - Common Course--mounted on interdepartmental basis
AC - Soil Science and Agricultural Chemistry
AE - Agricultural Engineering and Land Planning
AS - Animal Science and Production
CS - Crop Science and Production
RE - Rural Economy and Extension

Note: With a comparatively small staff and a rapid turnover the Faculty has restricted the course work offered to those areas in which continuing staff competence will be available. There is the probability that expertise on subjects not listed will become available through new recruitment and the Faculty would, therefore, be prepared to offer interested students additional programmed self study courses in these fields by arrangement with the Faculty members involved.

Not all courses listed will necessarily be offered in any one year.

### Common Course

CC 401 Applied Statistics and Biometrics (Type A)

Emphasis is on a practical approach to the proper conduct of agricultural field and laboratory experiments in the crop, soil and animal sciences and on the analysis, interpretation and presentation of experimental results. Sampling of experimental material. Uses of Chi-square Tests of significance. Completely randomized and randomized complete block designs. Factorial experiments. Split-plot design. Missing plot techniques. Assumptions of the analysis of variance; transformation of data. Analysis of covariance. Linear regression and correlation Decision making in regard to the proper choice of experimental designs. Computer capabilities; introduction to computer programming.

OR

Economic and Social Statistical Methods (Type B)

(To be mounted jointly with the Faculty of Social Science.)

CC 402 Agricultural Development Strategy (Type A)

Study of the special problems of agricultural development in tropical areas including general theories of economic development with special farms on the agricultural sector. Study of social and political factors involved in agricultural development.

## Soil Science and Agricultural Chemistry

AC 401 Soil Conditions and Plant Growth (Type A or B)

Composition and constitution of soil. Soil colloids, soil atmosphere, soil water and structure. Cation and anion adsorption. Sources of plant nutrients and their uptake. Plant nutrient deficiencies and toxicities and their correction. Soil amendments characteristics and problems of different East African soil types.

AC 402 Soil Microbiology (Type A or B)

A study of the bacteria, fungi and actinomycetes that make up the microbial population of the soil. The effect of environmental factors on levels of microbial activity in the soil. The chemistry of soil organic matter and its role in maintaining soil productivity.

AC 403 Animal Biochemistry and Nutrition (Type A or B)

Ruminant and non-ruminant digestion. Experimental techniques in animal nutrition. Nutrient intake and efficiency of utilization. Feed additives. Protein, fat, carbohydrate, mineral and vitamin metabolism. Nutritional problems associated with grain legumes. Chemical aspects of human nutrition.

AC 404 Agricultural Toxicology (Type B)

Chemical and biological properties of pesticides commonly used in agriculture. Mechanisms of action including selective toxicity, selective accumulation, lethal modification. Biodegradability in the soil, plants and animals. Toxicity to domestic animals and man. Factors determining the safe rate of application of pesticides to different crops. Chemotherapeutic agents and antibiotics, their mechanisms of action and applications in agriculture.

AC 405 Legume Bacteriology (Type B)

A study of the symbiotic relationship between Rhizobia and legumes. The morphology and physiology of root nodules. Cross inoculation groups. Biochemical pathways of nitrogen fixation. Factors affecting the efficiency of symbiotic nitrogen fixation. The importance of legumes in maintaining productivity of East African soils.

AC 406 Nitrogen Transformations (Type B)

A detailed study of both the biological and chemical transformations of nitrogen occurring in the soil including mineralization, nitrification, denitrification, volatilization, symbiotic and non-symbiotic nitrogen fixation and leaching losses. The efficiency of crop utilization of nitrogenous fertilizers. The use of $N^1$ in the study of nitrogen transformations.

AC 407 Soil Organic Matter (Type B)

A study of the chemical and physical nature of soil organic matter. The formation of humus from crop residues and the role of microorganisms in the decomposition of soil organic matter. Organic soils and reclamation of swamp lands. Importance of soil organic matter in maintaining soil productivity. Organic amendments and green manuring.

AC 408 Agricultural Physics (Type B)

The physical environment, radiation, heat, heat exchange, humidity and evaporation. Physical properties of soil, the soil-water system, movement of water in soils. Water transport through the soil-plant-atmosphere system. Soil atmosphere, gaseous exchange.

## Animal Science and Production

AS 401 Advanced Feeding of Ruminant Livestock (Type A or B)

Factors affecting feed utilization efficiency. Central nervous, feed and animal factors affecting feed intake by ruminant livestock. The concept of heat tolerance in feeding ruminants. Energy, protein and fat metabolism in farm livestock.

AS 402 Avian Nutrition and Physiology (Type A or B)

Nutrient requirements for growth and production in poultry, emphasizing the use of feedstuffs produced in East Africa. Effects of equatorial conditions on physiological responses especially as related to lighting schedules or egg laying and other reproductive functions. Interrelationships of nutrition and physiological responses.

AS 403 Incubation and Hatchery Management (Type A or B)

Selection and care of hatching eggs, incubation methods, embryonic development and production of baby chicks.

AS 404 Poultry Meat and Egg Products Technology (Type A or B)

Methods of selecting, processing, grading, storing, packaging and distributing poultry meat and eggs, stressing factors relating to the maintenance of high quality products.

AS 405 Milk Secretion (Type A or B)

The anatomy and physiology of the mammary gland. Physiology of milk synthesis and secretion and hormonal relationships.

AS 406 Advanced Animal Genetics (Type A or B)

Environmental physiology in relation to livestock production. Recording, breeding and selection programs in farm livestock. Population genetics.

## Crop Science and Production

CS 401 Agronomy - Crop Physiology (Type A or B)

Advanced study of: crop growth and its parameters, sinks and internal competition for assimilates, relations with biological productivity and crop index. Crop density competition functions. Radient energy, carbon dioxide, water, macro and micro nutrients as environment factors, their interactions and mathematical treatment in relation to crop yield parameters. Negative factors of the environment. Recent advances in selected crop topics including research techniques.

CS 402 Crop Breeding Technology (Type A or B)

Methods and techniques in plant improvement. Application of genetic and evolutionary principles to plant breeding. Topics to be included: breeding systems in relation to yield potential and genetic gain; theories of pure lines, hybrids, synthetics and multi-line varieties; importance of genetic shifts and homeostasis in genetic manipulation; factors limiting the efficiency of selection and testing. Procedures and problems in ascertaining types of gene action; testing for general and specific comining abilities and estimating heterosis, inbreed depression and heritabilities.

CS 403 Crop Protection (Type A or B)

Fungal, bacterial and virus diseases of crop plants; host-parasite relationships, ecology, biometrics and control systems. Insect, mite and nematode parasites of crops host-parasite relationships, ecology, biometrics and control systems. Vertebrate pests and their control. Crop weed, types, interspecific competition, ecology, biometrics and control systems.

Bio-mechanics of crop protection chemicals. Bioassays.

CS 404 Agronomy of Grasslands (Type A or B)

Ecology of climax, sub-climax and sown grasslands. Growth and development parameters in relation to grassland productivity and quality of produce. The influence of environment factors on these parameters. The animal-grassland complex. Conservation of grassland products. Research techniques used in grassland agronomy.

## Agricultural Engineering and Land Planning

AE 401 Farm Power and Machines (Type A or B)

Characteristics of design, evaluation of performance, selection and management of mechanical power units. The choice and evaluation of tillage and other field techniques. Use of animals and equipment. Ergonomics of herd operations in agriculture.

AE 402 Advanced Soil and Water Engineering (Type A or B)

Data evaluation and processing in climatology and hydrology. Measurement and evaluation of soil physical and mechanical data. Design and maintenance of soil erosion control structures. Irrigation and drainage techniques and design. Open channel hydraulics and stream gauging. Catchment and watershed concepts in soil and water control. Study of soil and water engineering reports for East Africa. Preparation of sample reports and designs.

AE 403 Farm Planning and Design (Type A or B)

Geomorphology and landscape evolution. Evaluation of landform. Map appreciation. Principles and practices of cartography. Aerial photogrammetry and air photo interpretation. Advanced survey techniques. Soil survey and mapping. Land capability classification and mapping. Farm plan case studies. Preparation of sample farm plans.

AE 404 Processing Machinery and Techniques (Type A or B)

The design, selection and management of machinery for the shelling, threshing, decorticating, cleaning, grading, grinding, mixing and preservation of primary agricultural products. Drying, dehydration and extraction processes.

AE 405 Agricultural Materials, Design and Construction (Type A or B)

Engineering materials for agriculture, fundamentals of designs Local manufacture and design of farm structures and equipment, water supplies, dams and roads.

## Rural Economy and Extension

RE 401 Advanced Farm Management Economics (1 Unit) (Type A or B)

Farm management analysis and farm planning techniques; production function analysis; linear and non-linear programming; recursive programming. Simulation techniques. Practical applications to research, extension and agricultural planning in East Africa.

RE 402 Institutional Aspects of Rural Development (1 Unit) (Type A or B)

Social and economic aspects of agricultural production institutions; land tenure, division of labor. Social structure and culture; East African farm households and their resources; community life; leadership; social stratification and mobility; relations of the rural areas to the wider social system. Forces and theories of social change and their implications for development planning.

RE 403 Plan Formulation and Implementation (1 Unit) (Type A or B)

Planning organization and procedures for the agricultural sector. Analysis and plan formulation for agriculture: district, region, national sector, regional grouping, commodity market. Agricultural statistics for planning. Project and program planning. Agriculture in the national plan.

RE 404 Project Appraisal (1 Unit) (Type A or B)

Identification of projects. Project accounting. Concepts and measurement of rate of return. Cost-benefit analysis. Project description.

RE 405 Comparative Development Administration (1 Unit) (Type A or B)

Social change and administration institutions; cultural factors in administrative behavior; formulation of policy and methods of implementation; development plans and the role of private enterprise; administering the public sector; structures of organization; problems of system maintenance.

RE 406 Rural Development Research Seminars (1 Unit) (Type A)

Seminars on current research in the main areas of rural development-policy, production economics, marketing extension and rural sociology.

RE 407 Agricultural Development Policies in East Africa (2 Units) (Type B)

Agricultural Incentive Policies: The economic analysis of agricultural price, marketing and taxation policies with particular reference to East Africa. International trade theories and commodity markets.

Agricultural Production Policies: Development planning and project evaluation; the economic analysis of direct and indirect investment of public funds in the agricultural sector with particular reference to East Africa.

(This course is not available for credit to graduate students with a Makerere College first degree in Agriculture, Economics or Rural Economy.)

RE 408 Agricultural Marketing (1 Unit) (Type B)

Applications of economic theory to the analysis of agricultural market structure and efficiency; economics of transport, processing and storage; international commodity market analysis.

RE 409 Agricultural Extension (1 Unit) (Type B)

Comparative studies of agricultural extension organization in advanced and less developed programs.

RE 410 Agricultural Enterprise Economics (1 Unit) (Type B)

Methodological studies in the analysis of some enterprise efficiency; technical, financial and managerial aspects of the major tropical enterprises.